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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 423.

DOMESTIC ELECTRIC LIGHTING.

A LARGE section of our readers will read with special satisfaction the interesting communication in our other columns on electric lighting in private houses, which was brought before us by Mr. A. Rashleigh Phipps. The information given comes at a very opportune moment, and, we should say, is likely to lead to a considerable amount of business in house lighting by electricity. Coming from such a well-known architect as Mr. Phipps, who, we believe, was responsible for the introduction of electric lighting into the Savoy and Prince's Theatres, the tabulated results of 12 months' experience are calculated to inspire increased confidence in the future of this branch of electric lighting, and to that future we shall look with hope.

But notwithstanding our belief in the success of domestic electric lighting, and in the general accuracy of Mr. Phipps's results, there are several points in the statement to which we desire to call attention. In the first place it is perplexing to reconcile the cost of working the engine for 4½ hours per day as given by Mr. Phipps with the results obtained by calculation. Gas in this gentleman's neighbourhood costs 3s. per 1,000 cubic feet, and we doubt very much whether his engine can indicate nearly 2 H.P. with less than 60 cubic feet of gas per hour. This would make the cost per diem nearer ninepence, and, notwithstanding the figures quoted, in which there is probably some overlooked omission, we think our readers will agree that the cost as given by Mr. Phipps is too low. If, however, he can substantiate his published outlay, then so much the better for electric lighting. Another matter for consideration is the durability of the secondary batteries, about which so much doubt has been expressed. We believe that it is chiefly due to the uncertainty existing as to the life of these apparatus that private applications of electric lighting have been so few. Mr. Phipps's experience will do much to remove doubts and allay apprehension on this score. A third matter of the greatest importance is that of lamp economy and life. Mr. A. Rashleigh Phipps, who has had charge of his father's installation, informs us that amongst the many systems tried, the conclusion forced itself upon them that the Woodhouse and Rawson type of lamp was the most satisfactory.

Mr. Phipps is to be commended for his courage in embarking upon an experiment attended with so many risks, and the results of which were involved in so much doubt; and, in the face of his success, we can do no less than advise other gentlemen who have large establishments and who value their books, pictures and decorations, to straightway follow his example.

THE FRANKLIN INSTITUTE INCANDESCENT LAMP TESTS.

IT was with some degree of surprise that we read the strictures of the *Mechanical World* upon the management of the Franklin Institute respecting the tests recently conducted on incandescent lamps—surprise that that usually fair and impartial journal had so far forgotten itself as to speak, and speak strongly, without having previously acquainted itself with the facts. Our contemporary, in its issue of December 24th, said :—

"We print in another column a letter from a well-known firm of electrical engineers calculated to surprise the uninitiated as regards the manner in which certain incandescent lamps were entered for competition in some recent tests conducted by the Franklin Institute of America. It appears that several firms of electrical engineers, including the Swan, Maxim, and Woodhouse and Rawson, had refused to enter lamps for these tests, having no doubt satisfactory reasons for taking that course; but it would appear that a number of lamps, stated to be of the latter named firm's make, were entered without their knowledge or consent, half the so-called Woodhouse and Rawson lamps being supplied by the Edison Company, and the remainder from another electric lighting firm. We need not comment upon conduct so grossly unfair, or be surprised that the results of the tests should not be received by any firm of engineers as reliable. This conduct has been condemned, and rightly so, by the various electrical journals, and so the wrong done will to a great extent have been minimised. It is highly desirable that any tests of whatsoever nature which are sanctioned by the high authority of the Franklin Institute should be conducted with the most rigid fairness and impartiality, otherwise great harm is likely to be done to the injured parties."

Now, the manner in which the Woodhouse and Rawson lamps were obtained, together with the fullest particulars of the test and every detail connected with the matter, is faithfully recorded in the report of the Institute, and we would refer our contemporary to our leading columns of December 19th for further information regarding Messrs. Woodhouse and Rawson's ill-advised protest. In our opinion, there is no room for objection to the carrying out of the tests, everything in connection with which was fair, square, and above-board. How could it matter to the Franklin Institute what names certain lamps bore, so long as they were properly entered for tests by the competing companies?

MACHINES FOR THE ELECTRIC TRANSMISSION OF POWER.

THE machines which are at present effecting the electric transmission of work between Creil and Paris, states M. Marcel Deprez to the French Academy of Sciences, are not those which had been at first designed and constructed for that purpose. They have undergone considerable modifications, for reasons about to be given.

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When I undertook the construction of dynamos of great power and high tension, several points remained doubtful. It might be asked :

1. If the laws of electric induction would remain without perturbation on changing the proportions and the arrangement of the magnetic field ?

2. If the loss of work caused by self-induction, the action of which had been recognised in machines of low tension, would not be intensified in machines of high tensions having great lengths of wire ?

3. If the loss of work resulting from the displacement of the magnetism in the soft iron of the induced rings would not increase with the mass of iron of these rings ?

4. If the sparks produced at the brushes in the working of the ordinary machines, would not assume a dangerous importance in machines of high tension ?

5. If it would be possible to insulate sufficiently the various parts of the system so as to prevent the electricity at a high tension from escaping ?

The answers to these various questions might be obtained by the study of existing machines, and a very justifiable extrapolation would give every satisfaction. Still the certainty could be complete only after the construction and trial of the machines themselves. These, also, had to fulfil special conditions. They had to be industrial, that is, substantial, easy to remove and to repair. They were designed and constructed to answer these ends.

When tried at the beginning of this year, it was at once perceived that they had a defect in their construction, the consequences of which might be dangerous. The iron core of the ring was composed of plates of soft iron, which ought to have been carefully insulated from each other ; they were not insulated, or at least very badly. Hence the machines, when at work, produced in this ring interior currents of the kind of those known as "Foucault's currents," which absorbed an enormous amount of work.

As may be supposed, the time of the stoppage and the serious delay involved in this error, caused some trouble to those concerned in the experiments. I must here express my gratitude to M. A. Sartiaux. engineer, sub-superintendent of the working of the Northern of France railway. From the first, he saw that the defect, in spite of the gravity of its consequences, had only an apparent importance, and did not affect the principles of the project. His firm and enlightened support was a valuable assistance in the continuation of the operations and in their happy conclusion.

It was necessary to re-make those parts entirely ; moreover, the magnitude of the defect was such that all study of the operations became impossible, and that none of the doubtful points could be thoroughly elucidated. Finally, time was pressing, as a limit had been fixed for the experiments.

Under these conditions, I resolved to place myself in the surest conditions. Renouncing industrial arrangements, and sacrificing for the time being, mobility, substantialness, and, even to some extent, the convenience of insulation, I endeavoured to fulfil the electric conditions only, eliminating, as far as possible, every cause of mischance, and adopting the most customary and best known arrangements.

The induced rings, studied from this point of view, were constructed ; they are now at work between Creil and Paris.

During this construction, by way of experiment, one of the old rings was repaired ; the plates composing the core were separated and carefully insulated. This tedious and delicate operation was successfully carried out by the care of M. E. Sartiaux, the head of the telegraphic service of the Northern of France railway. The ring thus re-made, was put to the trial, and it was found that it gave all the results which had been expected. When studied first with a few coils of wire folded diametrically, then with a certain number of sections, and finally completely coiled, it always gave the electromotive forces which had been expected. Further, it permitted an answer to the questions pending, and we know

1. That the laws of induction suffer no perturbation, whatever may be the magnitude of the machines and the dimensions of their magnetic field.

2. That self-induction has no more importance in large machines, with many folds of wire, than in small machines with a less number. This truth, indeed, had been placed almost beyond doubt by the study of machines of the ordinary Gramme type, which I had compared with my first high-tension machines ; this study had shown that machines having sections formed by 4 metres of thick wire, and others having sections formed of 75 metres of fine wire, had exactly the same coefficient of loss.

3. That the work produced by the movement of the magnetism in the iron remained in all machines, approximately capable of being neglected.

4. That sparks at the brushes may always be avoided by establishing a due relation between the power of the magnetic field, the current developed, and the position of the brushes. It was further recognised that from this point of view machines of high tension were, in fine, more favourable than others, by reason of the relative weakness of the currents developed.

When these tests had been made, it would doubtless have been preferable to recur to the original rings, suitably repaired. But time pressed, the new rings were just completed ; they answered the demands of the experiment, and I had to make use of them.

It will be remarked that there has been no mention of insulation : this difficulty is not of a theoretical nature, and it was certain that it might be overcome by a proper practical study. The present machines, though not possessing all the arrangements which I had prepared to that end, have already arrived at a high point of perfection ; they bear very high electromotive forces, and very violent electric shocks.

As for the conductive line, its general insulation is very good, as well as the mutual insulation of its two component wires going and returning. It was impossible to find here an appreciable electric loss in spite of the extremely bad weather which we had to encounter. It may from the present be considered as certain that an aërial line, upon posts, carefully constructed, will be an excellent conductor for the electric transmission of power. Still, under the present condition of things, it remains exposed to one class of accidents when traversing towns. That the wire of the line may pass near conductors serving for telegraphy or other purposes, cannot be avoided. There may hence occur, among these conductors, temporary or continued contacts. By a regrettable chance, an accident of this kind took place the very day when a number of the members of the Institute kindly visited the Creil-Paris experiments—an honour for which I profoundly thank the Academy.

The consequences of these accidents are less serious than might be expected, considering the sparks which they produce. Well-constructed machines resist their action, and the machines, Creil-Paris, resumed their action immediately after the stoppage occasioned by a contact of this kind.

Still, such interruptions in the working of the machines will be easily avoided. They must retain the regular, satisfactory movement which MM. the Members of the Institute have been able to observe on this occasion. This result will be reached by practical study. Experience will show which of the conceivable arrangements must be adopted.

It is, therefore, permissible for me to say that all the points which might give rise to doubt as regards the electric transmission of great powers to great distances are now elucidated. If the machines now at work have not all the industrial qualities which might be wished, circumstances are the sole cause. The former models constructed possessed them, and nothing opposes their being given to the definitive types.

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THE CREIL EXPERIMENTS.

WE briefly stated in the REVIEW for last week that the experiments on the electrical transmission of power conducted by M. Deprez before members of the French Academy were not very promising. A partial explanation of the causes which occasioned the failure was also given, but, as it would doubtless be of greater interest to our readers to learn all that has yet transpired in connection therewith, we now publish the report presented by M. Sartiaux to the Academy, and which he entitles

An examination of the causes which have temporarily interfered with the experiments on the transmission of power between Creil and Paris.

I have caused the line for the transmission of power between Creil and La Chapelle to be examined in detail with a view to discovering the causes to which must be ascribed the incident which temporarily interfered with the experiments of transmission during the visit of the members of the Academy of Sciences to Creil.

The following is the summary of the observations made :

The telegraphic wire which serves for correspondence between the two sheds of the electric machines at Creil and at La Chapelle was brought into momentary communication, by the wind with the bare experimental line, by means of a tree which the heavy rain of the entire day had rendered a sufficiently good conductor. The current coming from Creil had been, in part, conducted away by the iron wire of this telegraphic communication, and had produced the spark observed at La Chapelle and at Creil, which burnt certain small pieces of apparatus.

A complete contact has been discovered between the wire of the artillery bureau of St. Denis and the upper wire coated with lead, serving for the transmission of force, which the former wire traverses near Fort La Briche. A discharge, it appears, had been produced at the bureau of the artillery.

The wire of Fort La Briche, which has been only recently laid down, had been placed at an insufficient distance from the conductors serving to transmit force. Finally, there was found, at a pole near St. Denis, an insulator broken and burnt at a point where the lead was destroyed and where the tarred tape, serving as an insulator, was burnt. What was the cause and what the effect it is not easy to decide. What is certain is that during the experiment sparks were seen at this post.

All the repairs are now completed and the line has recovered the perfect insulation of the first days. I have again had all the points of attachment of the cable inspected at each insulator.

In fine, the accident which occurred for the first time during more than a month is due to a defect in the insulation of the line of transmission, resulting from accidental communications with the earth, easy to be avoided. It appears to me that precautions should not be made light of and that an uncovered wire placed out of the reach of the hands, and at a sufficient distance from any adjacent telegraph wires is often preferable to a wire perfectly insulated as is ours during a great part of its length.

ON THE TRANSITION RESISTANCE IN THE ELECTRIC ARC.

IF the apparent resistance of the arc is measured in the ordinary manner, writes E. Edlund, in *Annalen der Physik und Chemie*, we find that it consists, so to speak, of two parts, one of which is independent of the length of the arc, whilst the other is proportional to it. If the resistance is designated as w, the length of the arc as l and two constants as a and b, then $w = a + b\,l$. This holds good if the strength of the current is kept constant whilst the length of the arc varies. The behaviour of the constants, a and b, differs in so far that b decreases when the strength of the current increases, whilst a is almost independent of the strength of the current and of the electromotive force of its source. Only, however, if these are so far reduced that an arc is scarcely produced at all, the value of a becomes somewhat smaller. These, my observations, have been confirmed by the most recent investigations.

The question may now be raised whether this constant, a, represents a transition resistance which occurs at the surface of contact between the electrodes and the air, or whether it has its origin in an electromotive force. The diminution of the strength of the current occasioned by a can be explained by either of these hypotheses. From reasons given in the author's earlier memoirs it follows that a represents an electromotive force which acts against the main current in an opposite direction.

Among the researches which have been recently undertaken on this subject, we will call attention only to the following :—

Fröhlich, who used in his researches the observations made in the laboratory of Siemens and Halske, came to the conclusion that both of the above hypotheses could be in harmony with these observations, but he seems to prefer the view that the constant, a, represents partly an electromotive force and partly a transition resistance. That a does not exclusively represent an electromotive force he thinks probable because, in that case, the force required would reach the value—in his opinion improbable—of 39 volts. Peukert has also made a number of observations on this subject, in which the strength of the current varied between 10 and 30 ampères. As it appears from my earlier researches, Peukert found that the apparent resistance of the arc might be expressed by the formula $w = a + b\,l$. If we assume that the constant, a, is an electromotive force, its value, according to Peukert, must amount to 35 volts. This value seemed to him so high, that he did not venture to assume that it could have its origin exclusively in an electromotive force, but must represent in part a transition resistance.

From my above cited observations it follows that a depends neither on the strength of the current nor on the power of its source, except the current is reduced to the lowest limit at which an arc can be produced. In my first experiments I calculated a as an electromotive force expressed in Bunsen elements. Seven successive experiments, performed with batteries of from 55 to 79 Bunsen elements, gave the following results :—

a = 24·616 ; 25·962 ; 25·354 ; 20·951 ; 21·637 ; 21·483 ; 23·119 ; giving as mean = 23·315.

This holds good if the arc is produced between carbon points of the kind usually employed for this purpose.

If we assume that 1 Bunsen element = 1·7 Daniell, and that the latter = 1·08 volt, then 1 Bunsen = 1·8 volt. If this last number is multiplied into the mean above given, we obtain 41·97 volt. The mean of this number and those found by Frölich and Peukert (39 and 35) gives 38·66 volt.

The view entertained by some investigators that the constant, a, represents in part a resistance of transition is in fact refuted by the research of Victor von Lang. By an ingenious method he succeeded in proving that the luminous arc contains a counter-electromotive force of 39 volts. As this value of the counter action in the arc is almost equal to the value of the constant a as given above, it follows that a so-called transition resistance in the arc does not exist, and that consequently the entire decrease of the strength of the current which arises by the introduction of the arc is occasioned by the resistance of the arc (b, l) and by the counter-electromotive force therein contained.

Here, however, it must be noted that as the determination of the values of a and of the counter-electromotive force were possibly made with carbon electrodes of different kinds, it would be desirable to repeat both determinations with one and the same arc.

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THE COMPETITIVE TESTS OF THE EDISON AND WESTON DYNAMO-ELECTRIC MACHINES.

AN advance proof of the following communication by Mr. C. F. Heinrichs to the New York *Electrical World* has been forwarded to us by Mr. Heinrichs for publication :—

Having carefully gone over the report of the special committee of the Franklin Institute and their tables of tests, and compared the same with other tests on record, I note that the data of the horse-power absorbed by the friction of the armature varies considerably from the results obtained by other authorities. I regret that several data required to check more fully the results published are not given ; thus the weights of the armatures and the pressure of the brushes upon the commutators are omitted, from which, with the number of revolutions, one could well calculate the H.P. absorbed by the friction of the armature, which, if found correct, would credit the value of the total H.P. as given.

There can be no doubt that armatures of the same makers, having approximately the same weight and number of revolutions, will absorb approximately the same H.P. in friction when running without load ; thus, when comparing similar tests with each other, they ought to show similar results. The items of armature friction and total H.P. absorbed, if taken too small, will show an enhanced efficiency of the dynamo, and discredit the total H.P. measured.

Careful tests have been made in London, in 1882, during the International Electrical Exhibition, by the appointed committee, having Prof. W. Grylls Adams, F.R.S., as chairman. The particulars and tables of tests were given by Prof. Adams in his inaugural address before the Society of Telegraph Engineers and Electricians, on January 10th, 1884. I shall refer to these tests, and also to the exhaustive tests of my own dynamo, made by Messrs. Alabaster, Gatehouse & Co., in London, March, 1884. The particulars of these tests were given in *Engineering*, and are also contained in Dredge's "Electric Illumination," Vol. II.

I have extracted from the above-named tests several data, and arranged the same with corresponding data from the Franklin Institute Committee report in the two following tables :—

TABLE A.

	Edison Dynamos.			Weston Dynamos.		Heinrich's Dynamo. A. G. & Co. Tables, test 5.
	Franklin Committee.		Prof. Adams's tables of tests.	Franklin committee. Table III., test 1.	Prof. Adams's table of tests.	
	Table VI., test 5,	Table II., test 1.				
Electrical energy in horse-power	68·25	35·67	12·52	28·47	10·65	7·53
Probable weight of armatures in pounds	800	500	200	400	200	50
Number of revolutions of armature	1092	1208	1096	1043	...	1680
Horse-power absorbed by friction of armature	·393	·437	1·565	·3115	1·337	·51

This table contains the extracted data of six tests made of six different machines by the authorities named. The quoted electrical energy in H.P. serves to indicate the size of the machines, and from the (probable) weight of the armatures, with the number of revolutions, one can roughly form an estimate of the H.P. absorbed by the friction of the armature. The other extracted figures show that the H.P. absorbed by the armature friction of the Edison and Weston machines, tested by the Franklin committee, amounts only to a fraction of a H.P., while the H.P. absorbed by the armature friction of machine of the same makers, but measured by Prof. Adams, is from four to five times larger, notwithstanding the latter machines are only one-fifth to one-third the capacity of the former.

Observing these facts, one cannot help asking : Which are the true or most probable figures ? In answer I will point out the fact that in Prof. Adams's tests, all H.P. measurements were checked with an absorption dynamometer. Practice has shown that under varying conditions all transmission dynamometers are unreliable, and no calculations ought to be made from their indications, but the indications should be observed and afterwards reproduced by applying an absorption dynamometer, from which the power absorbed can be got very exactly in foot pounds. Further, during the exhaustive tests of my dynamo it appeared that the armature, weighing 50 pounds, with 1,680 revolutions, absorbed ·51 H.P. Now, the Franklin Institute Committee has actually measured less power as being absorbed by an Edison armature (Table VI., test 5), weighing probably 16 times as much as my armature. (See machines 1 and 6 in Table A.)

All other measurements made by Prof. Adams of the other armatures, viz., the Brush, Gramme, Burgin, &c., agree well and are proportionate, which cannot be said of the Franklin Institute Committee measurements. In fact, the H.P. absorbed by the friction of an Edison armature giving out an electrical energy of 68 H.P. has been put down as ·393 H.P., while the H.P. absorbed by the friction of another Edison armature, of half the capacity, has been given as ·437 H.P. (See machines 1 and 2 of Table A.)

TABLE B.

EDISON DYNAMOS.

Tested by whom.	Electrical energy in H.P.	Total H.P. absorbed by dynamo.	H.P. absorbed by friction of armature.	Electrical efficiency.	Commercial efficiency.
Franklin Committee Table V., test 1 ...	12·51	13·284	·14	94·21	88·42
Prof. Adams's tables of test	12·52	15·27	1·565	91	74*

WESTON DYNAMOS.

Tested by whom.	Electrical energy in H.P.	Total H.P. absorbed by dynamo.	H.P. absorbed by friction of armature.	Electrical efficiency.	Commercial efficiency.
Franklin Committee Table IV., test 7	10·40	10·774	·167	96·53	90·10
Prof. Adams's tables of test	10·65	13·83	1·337	85	61*

* Calculated by the writer.

I have arranged, in Table B, extracts from tests of an Edison and a Weston dynamo, made by the Franklin Institute Committee, with tests of another Edison and Weston dynamo, but made by Prof. Adams. The dynamos of each maker are of the same capacity, and give almost the same electrical energy in H.P. during the tests. Thus the two results of each set of tests ought to correspond approximately with each other, but, as seen, the figures given by Prof. Adams of the H.P. absorbed by the armature friction is 11 times larger than the Franklin Institute Committee's results. Also the total H.P. absorbed is given considerably larger by Prof. Adams ; consequently the efficiency of the Edison and Weston dynamos is considerably lower than that given by the Franklin Institute Committee.

These serious differences in the results obtained by such eminent authorities led me to make calculations of the probable H.P. absorbed by the friction of the armature of the six machines of Table A. To do this I required to know the weight of the armatures, the pressure of the brushes upon the commutators, which are not given in the report. I had thus to find these data, and I got them on comparing my machine with the others. The weight of my armature is 50 pounds,

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which is one-tenth the total weight of the machine. I use the least copper (only 16½ pounds for an electrical energy of 7·53 H.P.); thus the probable weights of the other armatures, as given by me, are most likely smaller than in practice. Further, the pressure with which both of my brushes are held to the commutator I found to amount to 7 pounds for a current of 23 ampères; thus the probable brush pressure I accepted for the other and larger machines, giving a larger current up to 400 ampères, will also be found to be less than actually used.

The results of my calculations are given in Table C.

TABLE C.

	Edison Dynamos.			Weston Dynamos.		Heinrich's Dynamos. A., G. & Co. Tables, test 5.
	Franklin Institute Committee. Table VI., test 5.	Franklin Institute Committee. Table II., test 1.	Prof. Adams's tables of tests.	Franklin committee. Table III., test 1.	Prof. Adams's tables of tests.	
Diameter of bearings in inches	2⅜	2⅗	1½	1¾	1⅓	1⅛
Probable diameter of commutator in inches	5	4	4	4	4	3
Probable pressure of brushes upon commutator in pounds	12	10	8	10	8	7
H.P. absorbed by friction of bearings	·98	·67	·14	·3199	·14	·038
H.P. absorbed by friction of brushes	·559	·38	·27	·3347	·275	·283
Total H.P. absorbed by friction of arm ...	1·530	·99	·41	·6546	·415	·32

I used the following formulæ:

1. H.-P. absorbed by friction of bearing in journals:

$$\frac{\mu\, w\, (\pi\, d)\, n}{33{,}000} = \text{H.P.}$$

μ, coefficient of friction = ·054;
w, weight of armature in pounds;
d, diameter of bearings in feet;
n, number of revolutions per minute.

2. H.P. absorbed by friction of brushes upon commutator:

$$\frac{\pi\, d\, w\, n}{33{,}000} = \text{H.P.}$$

d, diameter of commutator in feet;
w, pressure of brushes upon commutator in pounds;
n, number of revolutions per minute.

Comparing the calculated results with the measured results of Table A, it becomes evident that the H.P. absorbed by the friction of the armature, measured by the Franklin Institute Committee, is given too low, while Professor Adams's results are larger than the calculated. The latter fact can well be explained, viz., that the data upon which I found my calculations are taken too small; on the other hand, my calculations would only show what results could be obtained, under the most favourable conditions of the frictional surfaces, such as in practice we do not always have. New machines will have greater friction, and the coefficient becomes much larger.

Further, in my calculations no account has been taken of the resistance of the air, which is considerable if the armature is slightly uneven, and in fact the armatures are always more or less uneven; all these considerations explain well the differences between the calculated and the measured results of Prof. Adams. The actual H.P. absorbed by armature friction may be larger than the calculated; *but it cannot well be smaller* than the amount appearing from the figures of the Franklin Institute Committee.

The results obtained by Messrs. Alabaster, Gatehouse and Co. of the armature friction of my dynamo are also larger than my calculations show, which proves that the correctly measured H.P. would be more reliable than the calculated, while the calculated H.P. will serve as a check against errors and too small values being accepted.

The horse-power tests of the Franklin Institute Committee are altogether in the other direction. Thus the tests of the large Edison machine (see Table A) show the total armature friction to be ·393 horse-power, while my calculations in Table C show the mere friction of the bearings to amount to nearly three times that amount.

These differences cannot well be explained, particularly when comparing the weight of that large Edison armature with the weight of my small armature, which absorbs ·51 horse-power. Adding the other unproportionate figures given in this item, further, the great differences between the committee results and the more probable results of Professor Adams, one cannot help rejecting all horse-power measurements made by the committee, and the efficiency of the Edison and Weston dynamos stands unsupported. The only figures on record are those of Professor Adams.

	Efficiency. Electrical.	Efficiency. Commercial.*
Edison	.91	74
Weston	.85	61

* Calculated by the writer.

In the tests of my dynamo the H.P. absorbed *for producing the electrical energy* was calculated from Prony brake readings (see description of tests), which were taken under conditions excluding any doubt as to the results obtained being correct. The H.P. absorbed by the armature friction agrees well with Professor Adams's tests and all the before stated facts. Thus the high efficiency given to my dynamo stands well supported by the tests which have proved it to have the highest efficiency on record, viz.: Electrical efficiency, 98 per cent.; commercial efficiency, 76 per cent.

If the dynamo be constructed as a shunt wound machine, it will give a still higher commercial efficiency.

CHARLES F. HEINRICHS.

New York, *Dec.* 11*th*, 1885.

THE ELECTRIC LIGHT IN PRIVATE HOUSES.

THE following communication by Mr. Charles J. Phipps, F.S.A., has been handed to us for publication:—

Having now tried for 12 months the experiment of entirely lighting my residence and offices with the electric light, the result of my experience may be of some general interest. The installation here was carried out by the Electrical Power Storage Company with 27 of their patent accumulators (31 L type), 24 of which are in constant use, with three in reserve. The power is obtained from an Otto gas engine, erected by Waygood, of 1 horse-power nominal, indicating nearly 2 horse-power, and an Edison dynamo of 90 volts 16 ampères. The house, including bed rooms, is lighted by 50 Swan incandescent lamps of 50 volts and 20 candle-power each, burning a current of 1·3 ampères per hour.

On the 31st of October the installation had been working 12 months most successfully; in fact, during this period we have never been without the light for a single night. There have been one or two slight breakdowns with the engine and dynamo, necessitating the stoppage of work for one or two days, but on each occasion the amount of electricity stored in the accumulators has been sufficient to keep the house well lighted for nearly a week. The accumulators after their 12 months' work do not evince any signs of deterioration, and I am informed that they should last for some years yet, and, when necessary to replace the plates, it

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can be done at a small cost. The Edison dynamo gives a current varying from 12 to 15 ampères, which, from such a small power engine, is very satisfactory. The armature makes from 1,260 to 1,320 revolutions per minute, and there is not the slightest heating in any part of the machine. The 50 lamps throughout the house are all turned on and off by separate switches, with the exception of the cluster lights, or "electroliers," in the principal rooms, which have one switch for each cluster of five or six lights. In each bed room are two lamps in the usual position by the dressing tables, one of which can be turned on just inside the door, and the other by the bedside, and this mode of arranging the switches at the entrance to each room has been generally adopted ; attached to each switch is a safety fuse. The dining room having an enriched plaster ceiling, the question of carrying the wires was one of some difficulty, but it was so managed by careful manipulation that the most critical observer would fail to detect the mode in which they are carried round delicate mouldings from the wall to the centre of the ceiling.

The engine has worked on an average for the year 4½ hours a day, at a cost per diem of a fraction under 6d. The total cost of the installation, exclusive of fittings, was about £300. The engine and dynamo has been looked after by an electrician, who comes generally every other day, but the daily working of the machinery for the first nine months has been under the superintendence of my son, since which time one of the gentlemen in my office has taken it in charge. The working expenses have been as follows :—Payment to electrician, £12 12s. 6d. ; gas for engine, £8 15s. 2d. ; repairs to engine, £1 19s. ; oil for engine, £2 4s. 1d. ; repairs to dynamo, 7s. 9d. ; brushes for dynamo, 13s. 9d. ; attachments, 9s. ; breakage of 15 lamps, at 5s., £3 15s. ; waste, laces for belt, and sundries, 8s. 9d. ; total, £31 5s.

I have also kept a register showing how many ampères have been burnt nightly by each lamp, and by that means can tell to an hour the life of every lamp that has broken. The machinery is in a room about 11 ft. by 10 ft., on the basement, and immediately under the room in which I pass most of my time, and there is not the slightest vibration or noise. I am quite convinced that for absolute steadiness of light the working by means of accumulators is the best plan, and whenever the lighting by electricity takes a more extended form, and "centres" for producing it are established, accumulators, it appears to me, will then be advantageous to prevent the pulsation of the lights, and to provide against a possible break down of machinery at the "centres." At the end of the 12 months' trial I am quite satisfied with the result of my experiment ; the rooms are never overheated from the fumes of gas, and the ceilings and wall decorations are as clean and free from deterioration as when first put up.

THE PROFITABLE SECTION OF AN ELECTRICAL CONDUCTOR FOR THE TRANSMISSION OF POWER.

THE question was recently put to me, says Mr. Thomas Whiteside Rae, C.E., in the New York *Electrical World*, whether or not the cross-sectional area of a copper conductor intended to convey a current of some magnitude a moderate distance for power purposes was needlessly large, and I found the investigation so interesting, and involving so many generally unsurmised factors, that it seemed to me a worthy subject for a monograph.

The amount of power to be circulated in the form of current was 500 horse-power, the length of the circuit 4,000 yards, or 2·27 miles, and the cross-section of the copper conductor 3·25 square inches. The potential of the current was restricted to 120 volts.

The current equivalent of 500 horse-power being 373,000 volt-ampères, it followed that the theoretical value of the current flowing in the circuit would be 3,108 ampères.

This, however, is subject to correction for the loss involved in the conversion of mechanical work into current ; which is due to the frictional and electrical resistances of the generating dynamo, and whose minimum—so far as known—is about 13 per cent. It will be prudent and more in accord with other conditions of the problem—to be stated later—to put this loss at 15 per cent., and consequently there may be considered to be a current of 2,642 ampères flowing in the conductor.

It is evident that the flow of any appreciable current in any practicable conductor must evolve heat. If a uniform temperature of conductor is to be maintained, this development of heat must be got rid of by radiation or conduction ; or it becomes cumulative and detrimental, by creating a wasteful resistance in the circuit and, in the case of insulated conductors, sometimes destroying the insulating medium.

The latter class of conductor would seem to offer especial difficulties, and the problem is as yet too new to have invited much investigation or experiment. While it is undoubtedly true that the best dielectrics are, probably without exception, the worst conductors of heat, and the rates of their efficiency, in this sense, practically unknown, it has also been experimentally demonstrated that insulated conductors have even less tendency to augment temperature under the passage of a current than bare wires. This is a deduction from laboratory tests, and must be accepted only within proper limits. The seeming paradox vanishes when one reflects that the worst possible conductor of heat is dry motionless air, and that the larger periphery of the insulated wire radiates the greater quantity of heat in the same time. The result would be reversed if the two types of conductor were exposed to draughts of wind ; but the instance is cited to show that the general formulæ are applicable to both classes. Without being willing to rest for an instant under the imputation of reflecting upon the utility — nay, the indispensableness—of sound generalisation, I cannot refrain from calling attention to the prominent part taken by judgment in every problem in physics. Every case may be said to be a special case, and in view of the numberless and unforeseeable influences affecting the temperature of a subterranean conductor two-and-a-quarter miles long, it seems almost finical to be calculating the effect of a few degrees due to current resistance. Nevertheless, the investigation is of importance.

It is presumable that a conductor buried in homogeneous earth and well below the frost line would retain about a uniform temperature all the year round, but that temperature would depend upon the nature of the soil.

It would naturally be one thing for clay, another for sand, and another for rock ; and none of these could be known except by experiment. In all probability, a conductor of any considerable length would pass through all varieties of soil, across places alternately dry and wet, possibly near steam pipes, and any attempt to assign quantitative temperature to them would be farcical. In such circumstances, the only recourse is to general formulæ, as furnishing — all things considered—as fair an average of the conflicting influences as possible, and one of Clark and Sabine will do as well as any. It is

$$\theta = 0{\cdot}2405 \, \text{R} \, \text{C}^2 \, t,$$

in which

θ = units of heat.
R = resistance in ohms.
C = current in ampères.
t = time of flow in seconds.

Since the current in this case is practically continuous, t will disappear, and the factor, R, must be deduced, Clark and Sabine again furnishing the means with their formula

$$\text{R} = \frac{1002{\cdot}4}{w},$$

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w being the weight in pounds of a statute mile of the conductor whose resistance is sought.

In the case in question the weight of a statute mile is 65,261 lbs., and its resistance at 60° Fahr. consequently ·01536 ohm; making the resistance of the entire 4,000 yards ·035 ohm.

Carrying out the operations indicated by the formula, it will be found that

$$\theta = 58756\,;$$

that is to say, the given current will develop in the given conductor so many units of heat.

If it were conceivable that the substance of the conductor was water and weighed just 58,756 pounds, this would mean that its temperature would be raised one degree Fahrenheit. But its material is copper, whose specific heat is ·092 or—familiarly speaking—which requires but ·092 of the quantity of heat that water does to affect its temperature equally; and its weight, as has been seen, is 148,320 pounds.

Adapting the result to these conditions, it will appear that the conductor under consideration will have its temperature raised by the current circulating in it, only 4·17° Fahrenheit, above what it would be if out of circuit.

This increment is so trivial with regard to any harmful influence it might exert upon the insulating medium used with the conductor, that search must be made in other directions for the reason which prescribes its seemingly excessive size.

Good gutta percha will endure a temperature of 120° Fahr. before failing, and India rubber 300° Fahr. So the cause sought for is probably supposed to be the reduction of current, and consequently of merchantable horse-power, resulting from an increase of resistance by augmented temperature.

The resistance of copper increases $\frac{21}{100}$ of one per cent. for each additional Fahrenheit degree of temperature, and in the case of the predicated current and conductor, the resistance of the latter will be enhanced but $\frac{86}{100}$ of one per cent. For the purposes of discussion, the loss of current due to this augmented resistance will be ignored for the present. To estimate the effect of such increase of resistance from a financial standpoint, the subjoined method is convenient.

The 2,642 ampères of current flowing in the conductor are subject to a farther diminution, before they appear in merchantable shape, which occurs in their transformation by the converting dynamos into horse-power.

It may be safely taken at 17 per cent.; which amounts to the admission that, of the 500 horse-power applied to the generating dynamos, but 70 per cent. may be counted upon returnable, in the same form, from the converting dynamos. One of the postulates of the problem was that at least this proportion of the applied mechanical power should be recovered after having undergone all its transformations, and the loss has been equally divided—which is probably as fair an allotment as possible—between the two conversions.

There should be, then, 350 horse-power available for the production of revenue; but, owing to an idiosyncracy of electric power there is very much more. An instant's reflection will satisfy one that where an amount of power is distributed among a number of consumers for intermittent use the chance of every one's desiring to avail of his power at the same instant is infinitesimal, and experience, as far as it goes, confirms this. The character of the work done may also originate compensating influences to the same end, as when the power circuit includes elevators which not only consume no power in their descent but even reinforce the main current with the counter currents created by their own dynamos revolving under stress of their downward gravitation. It would be difficult to make too much of this characteristic, to which is largely due the wonderful economy inherent in this system of power distribution, and which is so prominent in the case of electric railways as to elicit the statement from the late Sir William Siemens that two trains on the same pair of rails, one ascending and the other descending a grade, influenced each other through the common current as absolutely as if connected by an actual rope.

It is this instantaneous adjustment throughout the entire circuit of the supply of, to the demand for, power that precludes waste or superfluity of it.

It is, therefore, considered perfectly prudent with an ordinary power plant to contract to deliver about double the total capacity of the generator.

In the problem under discussion, the quantity of marketable power was limited to 500 horse-power, which represents an annual rental of $60,000.

It thus appears that every one of the 2,642 ampères of current flowing in the conductor has a market value of $22.71 per annum.

On the other hand, the specified conductor—at the present depressed price of copper, say 15 cents per pound—would cost $22,248; the annual interest on which, at 6 per cent., would create an annual debit of $1,335.

Ohm's fundamental law of currents furnishes a useful point of reference at this juncture, viz.:

$$C = \frac{E}{R}$$

in which C = current in ampères,
R = resistance in ohms,
E = electromotive force, or potential, in volts.

As the latter factor is fixed at 120 volts, unity may be substituted for it in the formula, viz.:

$$C = \frac{1}{R}$$

which then signifies that the current varies as the reciprocal of—or inversely as the resistance. Colloquially, it reads: having the same electromotive force, to double the current, halve the resistance, and *vice versa*.

In conductors of similar material and equal length, the relative resistances would be inversely proportional to their cross sections—*or to their weights*—and the final deduction is that currents of uniform potential moving in conductors of the same material and of equal length vary as the weight of the conductors.

A convenient unit of comparison is the annual market value of the ampère which, as has been shown, is $22.71. As the number of saleable ampères in the case in point is a function of the weight of the conductor, the annual interest upon which *per pound* is $.009, viz.:

$$\frac{\$1{,}335}{148{,}320} = .009$$

it follows that it would require the annual interest upon 2,301 pounds of copper, viz.:

$$\frac{\$22.71}{.009} = 2{,}523$$

to equal the annual value of one ampère.

Supposing the conductor to be reduced in weight by this amount and applying the rule deduced for this especial case—of the current varying as the weight—it appears that such a reduction would diminish the current some 108 ampères, viz.:

$$\begin{array}{r} 148{,}320 \\ 2{,}523 \\ \hline \end{array}$$

$$148{,}320 : 145{,}797 :: 2{,}642 : 2{,}597$$

$$2{,}642 - 2{,}597 = 45$$

whose annual value is $1,022.

It thus becomes evident that the diminution of weight would entail vastly greater loss of revenue than the annual saving achieved thereby. Reducing the two opposing quantities to a common unit will give useful constants for the case under discussion, viz.:—

Annual interest at 6 per cent. on 1 lb. copper = $.009.
Annual revenue from 1 lb. copper = $.40
Weight of copper per ampère = 56 lbs.

From which it appears that until the price of copper rises 45 times above its present figure, or the value of

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the ampère falls the same number of times below that assigned to it in the comparison, or a change occurs in both, producing a similar mutual relation, any reduction of weight in the conductor—all other factors remaining constant—would be a source of loss rather than of profit. Since it seems incontestably proven that for the stated case and specified conditions any diminution of the conductor would be prejudicial, it becomes of interest to know if the weight might be profitably increased.

It will be remembered to have been shown early in the discussion that the given current raised the temperature of the conductor 4·17° Fahr., which increased its resistance ·86 of one per cent.

Since current varies inversely as resistance, viz.,

$$100{\cdot}86 : 100 :: 2{,}642 : 2{,}619 + 2{,}642 - 2{,}619 = 23,$$

it appears that this trifling increment reduces the flow by 23 ampères, whose annual value is $522.33. In the given conductor and under the prescribed conditions, each ampère requires 56 lbs. of copper, and the addition of 1,288 lbs. (56 × 23 = 1,288), the interest on whose cost is but $11.59, would make good this very considerable annual loss. Increasing the conductor by this amount of copper would enlarge its cross-section from 3·25 to 3·30 square inches—a barely appreciable area.

It is evident that the method employed is only approximative, and may be continued to any desired degree of precision. There is no pretence of close accuracy, and it is even less than it might easily be, on account of ignoring fractional quantities and the ordinary small errors in the deduced factors made use of. The idea has been to rather suggest a method of dealing with such questions than to furnish absolute results. It seems to show that the formula published by Clark and Sabine is sufficiently exact for any case in ordinary practice.

The reasoning is rational rather than analytical, and probably could not be expressed by a mathematical abstraction. At all events, I am not sufficiently facile in the processes or symbolism to attempt it myself, and commend it to the attention of such as are.

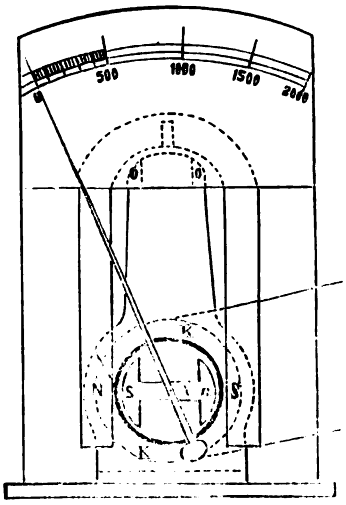
AN ELECTRIC SPEED INDICATOR.

THIS indicator is the invention of Dr. Th. Horn, of Leipsic, Germany, and the instrument is based upon the well-known Arago experiment of causing the needle to be deflected in the same direction in which a copper disc above it is rotated, the deflections being proportioned to the speed of rotation. Since each speed corresponds to a certain deflection, the principle can be applied in a speed indicator.

The instrument is shown in the accompanying illustration, the weak directive action of the earth's magnetism being replaced by more powerful permanent magnets, N, S. The needle is replaced by an I-shaped armature of soft iron, which is movable between the poles, N, S. Instead of employing a disc, a thick cylinder or sheath of copper, K, is placed around the armature, which latter is far more affected than if a disc were used. Within the limits of 40° to 45° the deflections are proportional to the speeds, and hence the apparatus is a practical speed indicator.

The question naturally arises as to the constancy of the deflection with a certain speed when the strength of the directing magnet, N, S, varies. If we assume that the magnet consists of two equal sheets or lamellæ, and imagine one of them to be removed, then not only will the strength of the poles, N, S, be reduced one-half, but those also of the armature, n, s, will be similarly affected, provided the latter was not magnetised to saturation. Since the attraction between the poles N, s and S, n is proportional to the product of their strengths, the torsional moment between the armature and directive magnets for a particular position will only be one-quarter of the original.

But it is easy to see that the deflecting power of the rotating sheath is also reduced to one-quarter of its original value, since with constant speed the currents generated are reduced one-half, corresponding to the strength of the poles, n, s, the amount of deflection being the product of both. The forces acting with diminished magnetism are in the same relative proportions



as originally ; in other words, *the deflections of the armature* (and consequently of the pointer) *are independent of the strength of the magnets.*

This explanation, says Dr. Horn in the *Elektrotechn. Zeitsch.*, is fully borne out by actual experiment. During the course of the latter, an electro-magnet was employed, the strength of which varied proportionally from one to four, but with constant speed no perceptible change in the deflection was observed.

MAGNETISM.

By WILLOUGHBY SMITH.

IN my position as electrician to the Telegraph Construction and Maintenance Company, it has always afforded me much pleasure to know that each effort of mine to advance the knowledge of electrical science has been most favourably and kindly received by the members of my electrical staff. It has therefore been to me a work of love to compile this pamphlet on magnetism, which, I sincerely hope, may be the means of giving assistance to those who are already engaged in endeavouring to gain a knowledge of the subject, and also of exciting an interest in those who have as yet given no thought to it.

Let it be assumed as correct, it not being of the slightest importance for my present purpose whether it be so or not, that a Greek shepherd, Magnet by name, whilst tending his flock on Mount Ida, found that there were in parts of the earth around him peculiar hard substances, from which, if he placed his iron crook upon them, he had difficulty in detaching it. Neither is it, at this time, of material importance to know the date of this discovery ; but it may be noted, in passing, that it must have been a very long time ago, as Homer, Pythagoras, Aristotle, and other celebrated men of their time mention it in their writings. It is even asserted that Thales, the most ancient philosopher of Greece, was acquainted with the attractive power for iron possessed by the substance called magnet, this name being given to it, I suppose, with the view of perpetuating the name of the discoverer of what must have seemed in those days a supernatural phenomenon.

It does not, however, appear that these ancient philosophers attempted to gain knowledge by experimental research, although they were such close observers of

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nature and its workings. No doubt the discovery of so strange and wonderful a phenomenon was a subject for much learned discussion and disputation in their schools of science; but they had not realised the important fact that theory and experimental research should go together, for useless is the theory that cannot be supported by experience, and experience, without some theory of generalisation and arrangement, would be nothing but a confused mixture of facts. Had this been more fully recognised it is possible that the most important property of the magnet—its directive force—would not have remained so long undiscovered. For it is recorded that it was not until the thirteenth century that it became known, at any rate in Europe, that when a magnet was freely suspended it turned one and always the same part of its surface towards the north pole of the earth, or a point not far from it; the opposite part of its surface, of course, pointing south; these parts were then termed poles.

When this directive force was practically applied to navigation and similar purposes, the magnet became more generally known as the "loadstone," a word said to be derived from a Saxon term signifying a "guide."

The magnet or loadstone is an oxide of iron of a dark gray or dark brown colour, found in almost all parts of the world, generally in irregular pieces of a few inches in dimension, although pieces have been found weighing over one hundred pounds and capable of supporting by suspension pieces of iron of double their own weight. It doubtless was soon observed that the directive force of these stones was very capricious, owing to the extraordinary difference in various parts of the same stone; for, while one part would attract, another would repel the same substance. This difficulty was surmounted by the discovery that by placing a plate of iron on each end of the stone, all the power of the stone appeared to centre itself in those iron plates and to give strong and uniform directive power. After the application of the iron plates it must soon have been observed that they, more or less, retained the property of the stone after their detachment from it, and that the harder the iron the more lasting was the effect. When the knowledge was fully recognised that the directive and attractive power of the stone could be imparted, without loss to itself, to hard iron or steel and permanently retained thereby, magnetised bars, or needles as they are now called, superseded the loadstone for ships' compasses and other like purposes, and the term magnet was again more generally applied. At the present time the word "loadstone" is very seldom, if ever, used, unless in application to the stone itself.

I have in my possession a natural magnet or loadstone. It is a magnetic iron ore of a specific gravity of 4·9, and, according to Bloxam, this variety of ore contains about 72 per cent. of iron. Its weight is 17,730 grains, but its attractive power is very slight, owing to its possessing what may be termed so many points of action. The attractive power at many of these points is scarcely perceptible; the strongest point will only support 17 grains of iron. But it will sustain a plate of iron weighing 1531·25 grains, if the iron be of sufficient surface to cover the whole of the base; and if the iron be extended so as to cover the two ends also, its attractive power will be increased to 24,062·5 grains. Taking the soft iron end pieces separately, while in contact with the stone, their respective attractive power is—

North	2645 grains.
South	2437·5 „

If one of the soft iron pole pieces be applied to different parts of the stone, then, as far as it is possible to ascertain, where any considerable attraction takes place between the stone and the iron, very little free magnetism is shown by the latter; but, if no attraction exists between them, free magnetism is manifested at the end of the iron. I cannot tell when this stone was first used for experimental purposes, but, forming my opinion from the antiquated character of the engravings on the brass case in which it is mounted, I should say it was at least 300 years ago; and, if I correctly interpret the engraved figures, its strength has, since that time, decreased more than 50 per cent. Writers on the properties of this class of ore or stone have frequently expressed their astonishment at the way this power, which we call magnetism, exists naturally in them. Even Faraday has said that "the way in which it exists at all times in a stone like this is the most remarkable fact connected with magnetic force." Whenever giving thought to the subject I always imagine the earth as one huge loadstone, and consequently look upon it in the same way as upon the small stone, the properties of which I have just given; for if the world could be experimented with in precisely the same way, similar results would be obtained, the only difference being the high attractive and directive power of the one over the other, owing to the vast difference in their dimensions. This would be analogous to experiments carried out with a huge magnet and a very minute portion of the same, for similar magnetic effects would be obtained in each case, but the difference of the intensity between the two would be very great. Astronomers consider the world an oblate spheroid body, elevated at the equator and depressed at the ends, and, for convenience, they imagine a line passing through its centre, and the extremities of this imaginary line they term the poles. Now at, or near, the place of these imaginary poles the earth has its strongest attractive magnetic power; consequently, proceeding from these two points are strong magnetic curved lines of force, which, by their polarisation effects, cause the atmosphere surrounding the earth to be one whole magnetic field. To what height those curved lines extend it is impossible to say, for we can only positively assert that the boldest aeronaut has not yet ascended beyond their influence.

When experiments in magnetism are being made, it should be constantly borne in mind that the work is being done in an atmosphere of magnetism, the lines of force of which vary in intensity according to the position on the earth at which the experiments are made; and not only the position, but also the time and temperature. If this be really the state of the planet on which we dwell, may it not be probable that the other planets, which are said, like this world, to be "swimming" in the medium of space around the sun, each one being surrounded by its own atmosphere, are similarly affected; and that polarised magnetic lines of force are the means employed by the great Architect of the universe (who, as far as our limited knowledge extends, employs no rectilinear motions or angles, but all motions created by Him are performed in curved lines) to bind together and control the whole system.

Having discovered the attractive and directive power, and the dip of the magnet, it appears to have been assumed that the whole subject was exhausted, as very little more attention seems to have been given to it, until Dr. Gilbert, in the year 1600, published his original treatise on the magnet. This created quite a new and enthusiastic interest in the subject, especially his hypothesis of terrestrial magnetism, in which he assumed that the earth contained within itself a powerful magnet, lying in a position nearly coinciding with its axis of rotation. Some of the enthusiasts of the day accepted this hypothesis as correct, and looked upon it as one of the greatest discoveries in the annals of science; whilst others propounded new theories which as fully illustrated how erratic is the unbridled imagination, especially when it has overleaped the bounds of reason. Although the advancement of knowledge will not allow of the correctness of many things recorded by Gilbert and other writers of his time, yet it may be still admitted, with truth, that Dr. Gilbert did much to increase our knowledge, and that he is justly termed "the father of the science of magnetism." The magnetic effects which were observed to be produced by lightning: Franklin's discovery of the identity of lightning with electrical discharges

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artificially produced: and the effects produced on magnetic needles by the aurora borealis, combined with the facts that similarly electrified bodies repel each other in the same way as those bodies which are similarly magnetic, and that dissimilarly electrified bodies will attract each other in the same way as those bodies which are dissimilarly magnetic, encouraged philosophers in their endeavour to identify the electrical and magnetic powers as one and the same. Powerful currents from large electrical machines, or from batteries formed of large Leyden jars, charged to their highest tension—the only known means in those days of generating and accumulating electricity—were passed through bars of steel or iron of all forms and under all conditions; but the results obtained were very slight and capricious, and showed no advantage over the magnetic effects usually produced by a blow given to a bar of iron from any mechanical action. Father Beccaria, a celebrated Italian philosopher, concludes his experiments in this direction by asking, "Are not these peculiar effects of this electric *fire* with respect to magnetism so many proofs which corroborate my former conjecture, that the peculiar magnetic force observed in *loadstones* is to be attributed to either atmospherical or subterranean strokes of lighting, and that the universal systematical properties of magnetic bodies are produced by an universal systematical circulation of the electrical element?" These remarks of Beccaria's do not appear to have attracted much attention at the time, but fifty years afterwards Ampère suggested a similar theory which attracted much attention, but then Ampère had had the advantage of two most remarkable and important discoveries which had been made since Beccaria propounded his theory.

It has often been found that experience produces facts which the wildest imagination never conceived even in its dreams. Bold, if not absurd, would have been considered the flight of imagination of the romancer who compiled his work from such incidents as those which belong to the history of Volta electricity. For instance, in 1790 an Italian lady slightly indisposed, was advised by her physician to partake of some frog broth; her husband, being an anatomist, at once proceeded to prepare the frogs, and, while so doing, observed that the disconnected limbs became convulsed with movements resembling vital action whenever they were touched at the same time with any two dissimilar metals, iron and copper for instance. The important results which have sprung from this simple incident illustrates the beautiful and unerring laws of nature developed under the most simple conditions, but which are too often, on that account, unheedingly passed by. This strange and startling phenomenon led to experimental research; and had Professor Galvani been more of an electrician, he probably would not have adhered so tenaciously to his theory of animal electricity. The results of Volta's experiments led him to assert that Galvani's theories were incorrect, and that the phenomenon was not due to animal electricity but simply to a current of electricity emanating from the surface of contact of two metals; but Professor Fabroni discarded both the preceding theories, and experimentally demonstrated that electricity was generated by the decomposition of the moisture lying between the two metals.

Each of these three hypotheses had their own partisans, but the controversy as to the origin of galvanic electricity, as it was then called, somewhat abated when, in March, 1800, Volta announced his discovery of the Voltaic Pile, composed of a combination of alternate discs of copper, zinc, and wet cloth. By this arrangement a generator of electricity was produced which gave a gentle and continuous current in large quantity, and not the sudden or instantaneous currents with uncontrollable and irresistible violence which had hitherto been obtained. From this discovery commenced the most splendid era in the history of electricity; it supplied experimentalists with a new implement for electrical research, amongst the former users of which was Sir Humphrey Davy, who, although a young man of only twenty-one years of age, not only put beyond doubt the fact that chemical action is essential to the vitality of the Voltaic pile, but showed different methods of generating currents, and thus localised, sufficiently for all practical purposes, the "seat of electromotive force in a Voltaic cell." A few years afterwards he published that most important discovery of the decomposition of fixed alkalies by currents of electricity generated by chemical action, and of the metallic nature of their bases, thus founding a new science of electro-chemistry. These discoveries burst so suddenly and unexpectedly upon the scientific world as to cause great wonder.

Electro-magnetism was again eagerly sought for, this time by the aid of the Voltaic pile, and, after twenty years of labour and thought, the experiments of Prof. Oersted carried him victorious to the desired goal; for he then discovered that an electric current, traversing a metallic wire joining the two poles of a Voltaic battery, will deflect an adjacent magnetic needle from its natural direction; and that, in the absence of interfering forces, the latter would be placed at right angles to the former; thus demonstrating, by actual experiment, that an electric current communicates magnetic properties, by induction, to such bodies in the vicinity as are susceptible of acquiring them. Prof. Oersted thus proved that there exists a reciprocal action between electric currents and magnetic bodies, and this was the foundation of the whole science of electro-magnetism. The discovery of the magnetic properties of electrical currents was at first received throughout the world with unqualified astonishment, as all previous attempts to identify electricity and magnetism had been unavailing. It was soon ascertained that Prof. Oersted had opened a new field of research, and its fertility was manifested by the great variety of interesting facts speedily brought to light by the emulative labours of experimenters; in fact, so rapid was the development of discovery in this new field of Oersted's that it was very difficult, if not impossible, for those whose attention could not be exclusively devoted to the subject to keep pace with its progress.

With the knowledge of Oersted's discovery, it would naturally suggest itself to every person giving thought to the subject, that if a conductor connecting the dissimilar metals of an electrical battery possessed magnetic properties whilst so placed, then it would be fair to suppose that all the effects which can be obtained from a magnet should be obtained from a wire so placed, and their experiments would naturally be in that direction. Amongst the foremost labourers in this new field of research was Ampère; who soon discovered that when two metal bodies are suspended or supported so as to be capable of moving either towards or from one another at the time that electrical currents are passing through them, they manifest a mutual attraction or repulsion, according as the currents are moving in the same or opposite directions. This phenomenon Ampère called electro-dynamics. M. Arago in France, and Sir H. Davy in England, about the same time made known, that if a metal wire, while being traversed by an electrical current, be plunged into iron filings it will retain around it a considerable quantity of the filings in the form of a cylindrical mass, the thickness depending on the strength of the current, and that immediately the circuit is broken the filings fall. This phenomenon further proved the magnetic properties of the wire while under the influence of an electric current. The following notes are from results of similar experiments which I have made in this direction:—The current must be of great strength to produce an appreciable effect; for instance, five ampères through a copper wire ·018 of an inch diameter. The larger the diameter of the wire the greater must be the current strength. Two Grove cells were sufficient to produce the effect with a very short length of wire, the greatest weight supported at any part of the wire being about one grain. Very fine iron filings settled round the wire, giving it the appearance of a circular brush. Copper, iron and aluminium all gave identically the same results, but with tin, zinc and lead, the necessary

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current could not be used on account of their low melting point. Arago and Davy also found that a steel needle became more strongly magnetised if the magnetising wire were bent into a helix and the needle placed in the axis of the helix, instead of the conductor remaining rectilinear.

The knowledge of this fact led to discoveries still more startling, for it was soon found that, if a rod of soft iron were placed in a helix formed of a wire of any conducting metal covered with an insulating material, a feeble current was sufficient to impart powerful magnetic properties to the iron rod, more especially if the rod were formed in the shape of a horseshoe so as to permit of both ends being used to attract the same substance. The magnetisation was instantaneous, appearing immediately the helix was connected with the battery, and ceasing, almost entirely, as soon as the circuit was broken. Such an arrangement was called an electro-magnet, and this discovery caused a great advance in the science of magnetism, for it furnished a means of acquiring immense, if not an unlimited, magnetic power.

Experimenters soon gave their attention to determining the conditions most favourable to the development of powerful electro-magnets, and the published results of some of their labours are so remarkable that it cannot be deemed unjust to suppose that their ambition to excel each other took possession of their imagination and left their reason unemployed. However, some of their experiments produced very curious, interesting, and valuable results. For instance, it was found that if a helix of insulated copper wire be placed horizontally, and one end of a rod of soft iron be presented at one end of the helix, it will be attracted into the helix and place itself so that its centre coincides with that of the helix, the result being the same whether the rod is shorter or longer than the axis of the helix. Again : a ball of soft iron of any diameter, providing it is not too large to enter the helix, when placed at the opening of the helix and being free to roll upon a very horizontal plane, in like manner rushes in and stops at the centre. So powerful can the action of a helix of this description be made, that if a magnetised needle or bar be placed within it so as to rest upon the lower portion of the helix, the moment the battery is connected to the helix the needle or bar will place itself in the axis, and so long as the circuit is maintained, remain suspended in the air in opposition to the force of gravity. In the centre of a vertical helix connected with a powerful battery, I have so suspended a rod of iron three feet long and 1·25″ in diameter, totally free from any material connection or support.

A helix of insulated wire enclosing an iron core and electrically excited, not only makes that iron a magnet, but is itself a magnet, and has a sphere of magnetic lines of force surrounding it independent of the lines of force given out by the iron which it surrounds, and the more intense the current passing through the helix the more intense will be the magnetic lines of force. This should be borne in mind when experimenting with helices or iron rods separately or combined. The law of action and re-action being equal and opposite, it might be expected that, as electricity produces magnetism, so, conversely, magnetism ought to produce electricity; thus, no doubt, reasoned Faraday, and the results of his experimental research in that direction brought to light several most valuable discoveries. Faraday wound a certain length of insulated copper wire round a cylinder of wood, and over this helix he wound a similar lengh of insulated wire. One of these helices he connected with a galvanometer, and the other with a voltaic battery; when the battery contact was made he noticed a sudden effect at the galvanometer, and a similar effect when the contact with the battery was broken, but in the opposite direction to the first deflection. This and similar phenomena Faraday called Volta-electric induction. He then wound similar lengths of insulated copper wire separately on to sections of a welded ring of soft round bar iron. When one of these helices was connected to a galvanometer, and the battery to one of the other helices, much greater results were obtained than with helices wound on wood. When a charcoal point was fixed to each end of the wire of one helix, and these points were brought close together, a minute spark could be perceived each time contact with the battery was made with one of the other helices. He also found that whenever the end of a magnet was passed suddenly into or out of the centre of a hollow helix of wire connected with a galvanometer, strong deflections were produced, but the direction of the deflection depended on the movement of the magnet; when entering the helix the galvanometer was affected in one direction, and when leaving it was affected in the opposite direction. The same results were obtained if the magnet were fixed and the helix movable. This agency, excited by ordinary magnets, Faraday called magneto-electric induction. Thus Faraday proved that electrical currents can be produced by magnets the same as magnetic effects are produced by electrical currents, but he believed they differed in one important respect, viz., that time is required for the development of magneto-electric induction, whereas he considered volta-electric induction to be instantaneous; but the latter is not borne out by the results of my published experiments on volta and magneto-electric induction. It was while engaged in those experiments that Faraday coined and circulated the terms " line of magnetic force," or " magnetic lines of force," " magnetic curves," " line or lines of electric force," " magnetic or electric fields," &c.

Magnetism has ever been a fertile field for hypothesis, and the discovery of electro-magnetism increased rather than diminished the confusion created by the number of theories that were promulgated to account for so remarkable a phenomenon. If the reasoning of some had been correct, it would have been necessary to have ignored the fact that man cannot create, destroy, or in any way alter the mysterious power with which the Almighty has endowed matter, which power is designated, for the want of more knowledge, gravity, heat, light, electricity, magnetism, and so on.

The analogy which exists between the phenomena of magnetism and those of electricity are such as to warrant the suggested probability that the theory which applies to the one might, with equal justice, be attributed to the other. Thus arose the one-fluid theory of Œpinus for magnetism, which is similar to Franklin's theory of electrical induction. The foundation of the hypothesis of two magnetic fluids, which is in many instances similar to Du Faye's two-fluid theory of electricity, was laid by Coulomb. Faraday assumed that all the particles of matter were *not* polar in their normal state, but became so by the influence of charged particles when either in contact or in sufficiently close proximity to them, the particles thus polarised being in a forced state, and endeavouring to regain their normal or natural condition. Thus his hypothesis that induction, which always precedes conduction, is an action of contiguous particles consisting in a species of polarity. The great similarity of action between common magnets, electro-magnets, and electric currents furnishes powerful reasons that the action is the same in all cases; consequently the theory which applies the more correctly to the one should apply equally to the other. The further I extend my experimental research either in electricity or magnetism, the more strongly do I become converted to the belief of the correctness of Faraday's views concerning these matters; but I am inclined to differ from him on one most important point, for I assume that each atom of matter possessses in itself all the properties of a magnet, and, consequently, emits its own lines of force; and, I further believe, that the molecular attraction known as " cohesive force " is one of the results of this all-pervading system of polarisation. Each atom existing in a polarised state, it follows, I think, that the outer ones, which form the surface of the earth, affect and are affected by the atoms of the air and other atoms in contact or in close proximity to them, and thus the system of polarisation is continued in curved lines throughout the whole atmosphere surrounding the

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earth, and constitutes what is termed "terrestrial magnetism." If this be so, it therefore follows that all particles of matter, solid, liquid, or gaseous, are in a polarised state, and consequently emit lines of force.

These lines arrange themselves so as to be in a position symmetrical to the lines of force emitted by any other body, the earth's magnetic field for instance; that is to say, the strongest polarised lines will control the weakest, and direct and attract them, as illustrated by gravity. But when forced from their normal position of equilibrium by any external agency, it depends on the energy of the same whether heat, light, or sound be developed separately, or the whole three combined, as instanced by the heat generated in a magnetic field, the light produced from it, the hum of the insect or other more significant causes, or the three combined, as in the lightning's flash and the thunder's peal. As soon as the cause of each phenomenon no longer exists, the lines of force regain their normal condition, and all is once more quietude.

All matter conducts electricity, but not in the same degree, in fact it is difficult with some substances to detect their conductibility. With an increase of temperature gutta percha and such like dielectrics decrease in resistance, while with copper and other good conductors their resistance is increased under the same conditions. All matter does not polarise to the same degree; in fact, with our present knowledge of instruments for this line of experimental research, we are only able to speak in positive terms of comparatively few; but with these few we learn that temperature affects polarisation, and, perhaps, if sufficient variation of temperature could be obtained, it might be found that, under certain conditions, lines of magnetic force might be made manifest from bodies which at the present time we least suspect. I assume it is not possible to decrease the normal amount of polarisation of atoms, but that it can be increased up to a certain point by external influences, as instanced by the conducting properties of matter, which is, I think, the result of forced polarisation. But if an attempt be made to exceed the maximum specific capacity for polarisation of any combination of atoms forming the material under experiment, then will be developed all the phenomena just mentioned, and eventually, if carried too far, disruption occurs, a phenomenon well known to electricians, and manifested generally in the destructive effects of lighting.

Of course, in a mere pamphlet such as this, it is impossible for me to notice all that has been done by eminent physicists in advancing our knowledge of magnetism. My object has been to give a simple and brief outline, and in so doing to call attention to some of the most prominent points in connection with the history of the same, which, perhaps, might prove of service to the earnest student, in leading up to a better understanding of the experiments which I am about to describe.

Having now completed my task so far, I will at once proceed to give the results of some experiments I have thought it necessary to make, as opportunity offered, to assist me in my search after the truth concerning that most wonderful phenomenon of nature which we call magnetism.

(*To be continued.*)

FRENCH ACADEMY OF SCIENCES.

THE BORDIN PRIZE.

THE question proposed for 1882, and postponed to 1885, was as follows:—" To find the origin of atmospheric electricity, and the causes of the great development of electric phenomena in storm-clouds."

Fourteen memoirs in reply to this question have been addressed to the Academy this year. Some of them are long and important investigations on the question proposed. Most of the authors of these memoirs begin by discussing the various hypothesis concerning atmospheric electricity, and indicating which, in their opinion, ought to be accepted; this portion of their work is, in general, the most elaborate. As for the causes of the great development of electric phenomena in storm-clouds, they have been studied imperfectly, or not at all, and in this respect the memoirs leave something to be desired.

The printed memoir of M. Edlund, Professor of Physics at the Swedish Royal Academy of Sciences (No. 1 of the competitors), having as its title: " On the origin of the atmospheric electricity of thunder and of the aurora borealis," has especially attracted the attention of the Commissioners by the novelty and originality of the views which it contains.

M. Edlund describes the development of atmospheric electricity to certain effects of electro-magnetic induction, which he terms unipolar induction. The fundamental experiment upon which these effects are based is that if a hollow conductive cylinder surrounds the one half of a permanent magnet, the axis of which is the same as that of the cylinder, the second half of the magnet being outside at the moment when the cylinder is set in rotation, there is produced in the direction of each of the generators of the cylinder a difference of potential depending on the direction of the rotatory movement, but which remains the same, and of the same direction, whether the magnet is fixed or movable, at the same time as the cylinder.

Setting out from this fact, and likening the earth and the upper portion of the atmosphere to conductors which turn without ceasing, and which are submitted to the influence of terrestrial magnetism acting in a constant manner, the author concludes that the air tends to take a positive charge and the earth a negative charge; further, this positive electricity is soon conveyed into the upper regions of the atmosphere, whence it directs itself towards the poles under the influence of this same magnetic force.

The air at the surface of the ground is not a conductor, but in consequence of the decrease of pressure its conductivity becomes sensible in the higher regions, which permits the production of the foregoing effects. Moreover, in those regions appears the aurora borealis, the electric origin of which is beyond doubt.

The positive electricity of the air, and the negative electricity of the earth, according to this hypothesis re-combine so as to give rise to an incessant movement of electricity, kept up by the inductive action of terrestrial magnetism. The author examines how the effects vary according to latitude, and he shows that the resistance to the neutralisation of the electricities, strong in the equatorial regions, diminishes on approaching the poles, so that in the former there are disruptive discharges, whilst in the high latitudes there are produced slow, almost continuous discharges.

M. Edlund has determined experimentally what may be the magnitude of this terrestrial electro-magnetic induction exerted on the earth and on the atmosphere. According to his estimates a difference of 1 metre in height in our latitudes should give rise to an increase of positive potential equal to about 0·023 volt, or 2·3 volts for a difference in altitude of 100 metres. This value is far less than that given by experiment when we study the distribution of electricity in the atmosphere under a clear sky. M. Edlund supposes that there is produced in the upper regions an accumulation of electricity which may give rise to the effects of storms and to the different phenomena which we observe.

The hypothesis proposed by M. Edlund is ingenious and developed with ability, but in the present state of science we cannot affirm that it accounts for the grand natural phenomenon the explanation of which is not yet complete. The Commissioners whilst making reservations in this respect, wishing to testify to this *savant* the interest which they take in his researches and to reward an original work of which they appreciate the value, propose to the Academy to award him the prize.

The proposal was adopted.

The " Grand Prize " of the mathematical sciences, consisting of a medal of the value of 3,000 francs, proposed for 1884 is postponed to 1886. It is required:

" To improve in some important point the theory of the application of electricity to the transmission of work."

Memoirs must be sent to the Secretary before June 1st, 1886. They must have a motto or device, which is to be repeated on a sealed note containing the name and address of the author. The note will not be opened unless the prize is adjudged to the accompanying memoir.

LAYING A CABLE.

IT was not much of a cable, after all, and its laying was no great performance, although forty years ago it might have been considered a marvel.

Science, in its so-called practical aspects, is now advancing in parallel lines; and these are so numerous, and some of them so far-reaching, that most men are unable to follow along more than one or two. This fact has suggested the idea that there may be something of interest to many in a description of this cable, and of the operation of putting it in the water.

It does not connect us with any foreign country; it does not complete the girdle round the earth: it is modestly content to serve as the link which joins the intelligence of the rest of the world with that of the interesting and important islands, Martha's Vineyard and Nantucket, where formerly the influence of the whale prevailed over all else, but now, alas! tributary to the state of Massachusetts, from which comes good government, and to the Standard Oil Company, from which comes petroleum, that arch

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enemy of the whale trade. But exclusiveness, even when aided by insulation, must give way to the progress of events. A glance at the map will show the nature of the forces operating in this case. Vineyard Sound is the great highway of the coasting trade. Thousands of vessels of all kinds pass through it every year. The harbours of Vineyard Haven (correctly named), Tarpaulin Cove, Lambert's Cove, &c., afford shelter for hundreds during rough weather. Wrecks are, unfortunately, not infrequent; and a visitor from the outside world is likely to see in the simple but perfectly neat and thrifty looking home of the fisherman-farmer a carved and upholstered chair, or something of the kind, which is referred to with no little pride as a relic from the wreck of some passenger steamer which went ashore with the loss of many lives and much property upon the coast near by.

The principal and sufficient reason for asking for a special appropriation from congress to secure telegraph communication with the mainland, was that stations of the U. S. signal service might be established on the islands, and particularly that danger signals might then be displayed from the more prominent points for the guidance of the numerous sailing craft constantly passing through the sound. Some years of effort were rewarded with success at the last session, an appropriation of forty thousand dollars having been made for the purpose of laying the necessary cable, amounting in all to less than thirty miles, and for erecting the land lines, display stations, &c. The work has been done, therefore, under the direction of the chief signal officer.

The cable was made in London, and shipped to New York in the hold of a steamer, coiled in two large tanks especially built in the steamer for that purpose. It fortunately happens that the gutta-purcha insulation, used almost exclusively for submarine cables, is improved and preserved by being kept damp, cracking and deteriorating when dry. For this reason it is necessary to keep the cable in tanks during its passage, so that it may be kept covered with water. The conducting part of the cable consists of seven copper wires, each about ·028 inch in diameter, six being twisted about the seventh as a centre. The resistance of this conductor was not to exceed thirteen ohms per nautical mile, and it fell considerably short of that upon being measured. This copper core was covered with three or four layers of gutta-percha, until the diameter of what might be called the cable proper was a little more than a quarter of an inch. Such a cable would scarcely last while it was being put down, and it is therefore necessary to put an "armour" upon it, so that it may be able to endure the destructive agencies to which it is likely to be subjected. The gutta-percha-copper core is wound with two or three layers of heavy jute twine, and this, again, with twelve number five galvanised iron wires laid on spirally. The result is apparently a strong iron rope about an inch and a quarter in diameter.

An examination of the cable was made in New York City, before its removal from the tanks referred to, for the purpose of seeing that its insulation was still intact. It was then transferred to a barge lying alongside, from which it was to be laid, and in which it was towed through the sound to Vineyard Haven. Its arrival at this place caused little less than a sensation. The first section of the cable was to be placed across Vineyard Sound; and, although not the longest, it was the section likely to cause the greatest anxiety. In fact, the Western Union Telegraph Company has several times tried to place and maintain a cable from West Chop Light on Martha's Vineyard to Nobska Point on the Mainland, but their efforts have not been altogether successful. The damage to a cable across the sound arises from two sources. The tidal current is strong, at some points nearly three miles per hour; the seaweed, which is carried back and forth by this current, is caught on any suspended or exposed part of the cable, and twisted around it until huge, solid masses are attached to it, which offer so much surface to the swift current that the cable must give way under the strain. The other source of danger is quite as disastrous, and nearly as uncontrollable. It is in the dragging of ships' anchors across the line of the cable. In this way the cable is caught in the anchor and brought to the surface when the latter is hoisted. A little intelligence, combined with good nature, would enable the shipmaster to release the cable and drop it uninjured; but more frequently, in his annoyance, he will deliberately cut it in order to escape, although release without injury could be accomplished in less time. In putting in this cable it was desirable to locate it so that the chances of damage from both of these sources might be reduced to a minimum. To this end the officers in charge of its laying did not need to seek advice from persons familiar with the waters, for it was freely offered by every inhabitant of the islands. The multitude included a few old sea-captains, who seemed to know every foot of the coast, and to understand the nature of the bottom of the sea; and it is believed that their words were words of wisdom. The route selected lay across the sound several miles to the westward of that already referred to. It is undoubtedly freer from probable damage arising out of the anchorage of vessels, but time alone can determine to what extent.

Every thing being in readiness, the barge was towed to the starting-point, which was the northern terminus of the cable on Naushon Island. As there was a good deal of a "sea" running, it was not possible to approach nearer than twelve hundred or fifteen hundred feet from the shore. The tug was anchored, and the barge was allowed to drift in a few hundred feet farther. A stout rope, an inch and a half in diameter, was then attached to the end of the cable, eight or ten men were put into a boat, and the other end of the rope was carried ashore. The end of the cable was dropped overboard, and the operation of pulling it to the beach began. This was finally successful, and the shore end was made fast to a stout post which had been erected for the purpose. All hands came on board, anchor was weighed, the barge made fast to the tug, and the journey across the sound was begun. The cable lay in two great coils in the barge, and dropped into the water over the stern. It passed around and over a couple of large reels or drums, where a large pulley-brake was applied to it in order to regulate the tension to which it was subjected. To one of the drums a counter was attached, so that the rate at which it was paying out could at any time be determined. Wind and tide opposed each other, and the rate of sailing did not exceed five or six miles per hour. The opposition of wind and tide was favourable to a straight course, and good pilotage secured a run across which undoubtedly put the cable down in almost exactly a straight line from the point of departure to the southern terminus on Martha's Vineyard. At this end the landing was a little more difficult. A rope was first carried ashore, its length measured as it went out, to determine where to cut the cable that it might reach the beach from the anchorage. On its next trip the little surf boat carried a small, weather worn 'A' tent, a rough bench, batteries, galvanometers, resistance coils, and two shivering signal service men, who were to test the cable as soon as it was landed. A rude testing station was soon established amid the hillocks of sand, and the instruments were in position when the cable was at last landed, and secured to a portion of the wreck of an unfortunate vessel that had stranded upon the shore many years before. But the high winds were still rising, darkness was coming on, and the captain of the tug, declaring that he had had enough of cables for one day, ordered all hands on board forthwith. It was impossible to leave the instruments in that condition, and the prospects for a night on the beach seemed good, when the hospitality of the owner of the one house within sight brought relief, furnishing a storehouse for the appliances, a well supplied table for keen appetites, and a waggon ride at night through the woods to the hotel, seven or eight miles away.

On the following day the termini were again visited, the ends properly secured, and the cable tested. A trench was dug in the sand down to low water mark, in which the cable was buried. At a point above high tide on the beach a strong post was erected, to which the cable was secured by means of a heavy chain; from which point, still underground, it was carried higher up the sand hills on which it had been landed, to the foot of an ordinary telegraph pole. It extended up the side of this, being enclosed in a box until it reached the top, where it entered the cable box proper, the end being secured to a binding screw ready for connection later with the land line. Some of the party had been sent to Naushon Island, carrying with them an ordinary telegraph instrument and key. By previous agreement it was to be connected with the cable at once on the arrival of the party. A few cells of battery and a similar instrument were joined to the end on Martha's Vineyard, and the two expeditions had been timed so accurately that almost instantly responsive ticks proved that intelligence was at work on the other side. Much interest is often felt in the first message transmitted through a cable or telegraph line. Brushing aside the romance of the thing, it is safe to say that in nine cases out of ten the first message is that which traversed the river first on this occasion, being simply "Do you get me now?" After some further interchange of compliments, the operator on Naushon was directed to seal up the end of the cable by covering the exposed wire with gutta-percha. This having been done, communication ceased, and the insulation was tested. A number of battery cells were joined "in series" to the galvanometer, which was a delicate instrument of high resistance, with a reflecting mirror, and to this the end of the cable was attached. The test was practically an endeavour to force the current through the gutta-percha insulation, the amount of the leak being measured by the deflection of the galvanometer needle. It had been demanded of the cable that it should show an insulation resistance of at least two hundred and fifty megohms per mile, and it greatly exceeded this number when tested.

A few days later, when wind and weather were favourable, the island of Nantucket was connected in a similar way with Martha's Vineyard, the cable taking a sweep out into the sea to avoid shoals; and finally a short piece, about a mile in length, was made to connect Naushon, by way of the little island Uncatena (always "Uncle Timmy" at home), with Wood's Holl, and thus was completed the union of these islands with the mainland which it is hoped may last for many years.—"M.," in *Science*.

The Edison Telephone Patent in Canada.—The taking of evidence before the Deputy Minister of Agriculture, on the application of the Telephone Manufacturing Company of Toronto, has been concluded and decision reserved. The application is to have the Edison telephone patent, now held by the Bell Telephone Company, declared void because of the importation, non-manufacture and refusal to sell by the Bell Company. The Bell patent proper was annulled last year, but the Edison patent still holds good, and, as the Bell Company has brought an action against the Telephone Manufacturing Company for an infringement of the last-named patent, this application is made to set it aside.

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NOTES.

Electric Lighting of the Blackpool Winter Gardens.—The directors of the Winter Gardens at Blackpool, having, as we have already announced, decided to light the gardens by electricity, have put the installation in the hands of Mr. M. Holroyd Smith, well-known in connection with the electric railway at Blackpool, and that gentlemen is now preparing plans and specifications. Tenders, we are informed, will be invited shortly.

Electric Lighting in the Leeds Town Hall.—The Electric Lighting Committee of the Leeds Corporation has decided to illuminate the Victoria Hall by means of arc lamps, at a cost of about £450. Secondary batteries, by the Electrical Power Storage Company, are to be provided, and these will be charged by dynamos which the Corporation already has in its possession in the basement of the Municipal Buildings. The current is to be carried from the Corporate Offices to the Town Hall along a subway now existing in Calverley Street, and thence into the "false" roof of the Victoria Hall, from which will be suspended eight 2,000 C.P. arc lamps with ornamental pendants. A small sub-committee visited Manchester to see several lamps tried, and they selected the Brockie-Pell. As the "electroliers," by means of which the Victoria Hall was lighted by Messrs. Crompton & Co. on the occasion of the last musical festival have not been removed, only a portion of the new arc lamps will be fixed to begin with. It is intended at the outset to hang two of the arc lamps in the middle of the hall, early in January, and before the scheme is completed the committee, and, possibly, the public, will be afforded an opportunity of witnessing the effect produced. The pair of twelve horse (nominal) power gas engines, which supply the dynamo power for illuminating the Municipal Offices, are at present standing idle all day, so that by the making of a battery installation for the Victoria Hall, the Corporation will not require any additional engine power, but will be able to fully utilise that which they already have, without extra outlay upon machinery. The two engines are coupled, so that should one dynamo break down, the whole of the power can be run upon the other dynamo. The preparations for putting the committee's project into execution, which are being carried out under the superintendence of the borough engineer's department, are approaching completion, and when the lamps come to hand they will be put in position and set going without delay.

Electricity in the Royal Navy.—An important addition to the active list of the Royal Navy has been made by the completion for sea at Sheerness of the new unarmoured composite corvette *Pylades*, which was launched in November, 1884. She has a displacement of 1,420 tons, and is fitted with machinery of 1,000 horse-power. Her armament is more powerful than that of her sister ships, and consists of 14 5-inch steel breechloading guns, mounted on the Vavasseur carriages. The *Pylades* is also equipped with Gardner and Nordenfelt machine guns, and the electrical machinery for discharging the spar torpedoes. The total cost of building and equipping the vessel is about £75,000.

Shop Lighting by Electricity.—An experiment, the object of which is to test the utility of the electric light for retail shops and private houses, is now being made in Wade Lane, Leeds, where the premises of Messrs. Walsh and Son, paperhangers, H. Cooke, tailor, and E. Yewdale, chemist, are lit in circuit from a dynamo worked by Mr. E. Walsh, engineer. It is stated that in this instance experience shows that the cost of the electric light is not so great as it has been represented, while those who have made the experiment are satisfied with the result so far as the steadiness and brilliancy of the light are concerned.

Electric Lighting in Middlesborough.—An industrial and art exhibition has just been opened in the Cleveland Hall, Middlesborough. The building is lighted by the electric light, seven 1,000-candle arc lamps being in use. Four of the lamps are hung in the upper hall, two in the lower hall, and one at the entrance to the exhibition. The motive power is supplied by an 8 horse gas engine, and the dynamo is a Brush six lighter.

Woodhouse and Rawson Lamps.—Les Fils de Peugeot Freres write to us from Valentigney (Doubs), regarding these lamps :—"In answer to your remarks respecting incandescent lamp tests, we are glad to state that a few Woodhouse and Rawson's, tried by us, gave good results as regards duration, economy, &c. We made very thorough and careful tests lately, during a run of 2,000 hours, with different makes, on our 1,200 Edison lamps station, and had we tested a few more Woodhouse and Rawson lamps, we might have been able to state very correctly on their general qualities."

Electric Lighting in Chicago.—Electricity for lighting is coming to the front in this city, says the *Chicago Manufacturer*. A careful estimate, based upon an extended experience in the use of the incandescent plant elsewhere, and upon the quantity of light actually used in the city hall and tunnels each day, would indicate that the cost of this light to the city will be the equivalent of gas at from 65 to 70 cents. per thousand feet.

Electric Light Shares.—Is the confidence of the public in electric lighting undergoing resuscitation ? A sudden activity has sprung into existence in the share dealings of several electric lighting companies ; but there is no self-evident cause to which we can readily ascribe this movement. We know that several companies have been quietly doing a steady business, and it is just possible that one or more will pay a dividend shortly ; whether that dividend, however, will be entirely upon business done or not we should not like to say. Then it is pretty confidently anticipated that when Parliament settles down, a considerable amelioration of the grievances of those who suffer under the Electric Lighting Act will be brought about ; and this might well influence the public in their purchases. The extension of Brush lighting in the City, too, has probably had an effect upon those who are on the alert for "a good thing." Perhaps the Maxim-Weston shareholders will flatter themselves—and their chairman—by tracing the renewed activity to the election of Mr. Hugh Watt to Parliament. At any rate, whatever the cause, let's hope it is not a rattling of dry bones, and that this will prove a happy augury for the electrical industry during the year that is now upon us.

The Dolbear Telephone Case.—Prof. A. E. Dolbear, writing to the *Scientific American*, says :—"In the *Scientific American* of November 28th, in the article on the Reis telephone, there is a quotation from the judgment of Judge Gray in the Dolbear case, in which is the statement that it was not denied that 'Bell was the first inventor of a speaking telephone.' This statement is ambiguous, and may be understood in two ways. It was admitted that Bell invented *a* speaking telephone. It was not admitted that Bell was the inventor of the first speaking telephone. A distinction was made between the telephone invented by Reis in 1861 and the telephone invented by Bell in 1876 as being unlike in principle though having the same function, namely, to transmit speech. It was affirmed at the outset that Bell was not the inventor of the first speaking telephone, but that Reis invented one long before, and this was reiterated time and again in the case. Judge Gray knew this, and he carefully framed his statement so as to convey the impression that admissions had been made which had not been made, and yet if the sentence was carefully scrutinised, it would be found to be rhetorically correct—a case of

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trifling with the language which one would not look for in a United States judge. The whole trouble lies in the use of the word *first*. It was admitted that Bell was the first inventor of (a particular kind of) a telephone. It was emphatically denied that Bell was the inventor of the first speaking telephone, and it was asserted that Reis invented a speaking telephone fifteen years before."

Proposed Telephonic Exchange in Stirling.—A meeting of gentlemen interested in the proposal to institute a telephone exchange in Stirling was recently held in that town, when Mr. A. R. Bennett, general manager of the National Telephone Company, spoke of the utility of the telephone, and explained that the proposed exchange would afford communication with the subscribers within a six miles radius from Stirling, the intention being afterwards to extend the communication to Glasgow, Dundee, Perth, &c. Mr. Mitchell Thomson, of Edinburgh, a director of the company, also addressed the meeting, and at the close several gentlemen signified their willingness to join the exchange.

Interruption to Telegraphic Communication.—Last Saturday afternoon a singular accident occurred at Newbury, resulting in the interruption of telegraphic communication between the metropolis and Bristol and other places in the West of England. A large walnut tree was being removed by a traction engine from one part of Newbury to another, and when passing through Northbrook Street the branches caught the line of wires which cross the thoroughfare and snapped them.

The Telegraph in China.—At the present moment an important line of telegraph is being constructed along the southern borders of China, through the provinces of Kwangtung, Kwangsi, and Yunnan. Starting from Nanking, in Kwangski, where it joins the Canton-Lungchow line, it will extend for nearly 600 miles to Nung-lik, in South Yunnan, running for half the distance along the Yukiang, the name of the Canton River in its upper course.

The Mackay-Bennett Cable Company.—The *New York Herald* of December 24th contains the following editorial:—"At the close of to-day, the Commercial Cable Company will be one year old in the public service. It started with rates 20 per cent. below those of the monopoly or pooled cables controlled by Jay Gould, and those rates have never been changed. The pooled cables were forced to reduce at once their charges to the figures of the new company. Thus the cable business for the year 1885 has been done for four-fifths of the cost under the monopoly of the previous year. This means that the cable-using public has been saved about $1,000,000 of the sum it formerly had to pay. The commercial community was quick to see and to avail itself of the advantages of the direct connections and improved construction of the new cables. From the beginning the enterprise has received the heartiest encouragement and support. The Commercial Cable Company during the year has never for a moment lost communication between the two continents, the commercial and financial interests of which are becoming more intimate every day. Improvement in the speed and accuracy of the cable service has done much and is doing more to increase this intimacy. It is but a few years since the delivery of a message across the Atlantic in forty minutes was regarded as marvellous. To-day by the Commercial cables messages are transmitted from this city to London in two-and-a-half minutes. Value of speed in arbitrage and other transactions calling for haste is obvious. It is not at all uncommon to have a message sent and the answer received within the space of ten minutes. The public is to be congratulated upon this remarkable annihilation of distance, and upon the numerous advantages which are certain to follow from it."

Atlantic Cables.—The New York *Electrical World* says in a recent issue:—"One of our English contemporaries given to the use of strong language, goes out of its way to advise 'that not a single farthing be invested in any new Atlantic cable company, as it is impossible that any return can be realised from such investment;' and it emphatically protests 'against any attempt being made to obtain money from the public for this purpose.' There can be no doubt that the present number of Atlantic cables is amply sufficient for the traffic; it was so even before the construction of the Mackay-Bennett cables, but we are free to say that the money invested in the latter is paying a fair dividend. Of course, cables with plenty of watered stock, find these times of competitive rates very dreary, and thus far we think the new Atlantic cables have had the best of the fight. The gratuitous advice of our contemporary seems, therefore, to be a plea for the protection of the old companies from further interlopers, rather than altogether disinterested warning. Certain it is that the public will not suffer by the construction of new cables."

Domestic Electric Lighting.—Mr. Phipps, F.S.A., has done good service by making public the results of a twelvemonth's trial of his electric lighting installation at Mecklenburgh Square. Surely many private householders will now follow this gentleman's example, domestic lighting being, on the face of it, both easy to manage and cheap to maintain.

Magnetism.—In our present issue we commence the republication of a pamphlet on "Magnetism," from the pen of an indefatigable worker in this interesting study. A careful perusal of this will well repay even the scientific reader, who will relinquish his task with the feeling that he has added not a little to his store of knowledge.

Dynamo Tests.—The letter of Mr. Chas. F. Heinrichs, which he has asked us to publish, is of an interesting nature, but it is more than probable that ill-disposed persons may look upon it as a means of ventilating the merits of his own machine, rather than as an impartial criticism upon the tests of the Franklin Institute. And, indeed, we think the matter at issue might have been best commented upon without any reference to outside machines.

Archimedes Redivivus.—A correspondent signing himself "Hiero" having now favoured us with his identity, we would call attention to his amusing lines on a well-known electrical tramcar system, which may be found in our Correspondence columns.

Electric Locomotion.—The first successful attempt at trial trips of the new cable car was made recently in Denver, Col., over a portion of the track of the Denver Electric and Cable Railroad Company on Fifteenth Street. The car ran a considerable distance, and, states the New York *Electrical Review*, at the satisfactory rate of eight miles an hour. A dynamo of 20 horse-power furnishes the motive power for the car. Prof. S. H. Short, of the Denver University, has worked very hard to make his invention a success, and his efforts seem to be already reaping their reward. The company hoped to get its cars running in a month or six weeks. The car which is now being used in making trial trips is shaped and fitted up very much like an ordinary street car, and is fully as handsome in its style and appointments as any street car in Denver. It was made by Woeber Brothers, of West Denver. The dynamo and other machinery, which is located in a building near the corner of Fifteenth and Tremont Streets, and which is used to propel the car, was made by F. M. Davis, of Denver, and all the plant and material used by the company will be of Denver manufacture.

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The Determination of Melting Points.—A simple contrivance has been introduced for the determination of melting points, states the New York *Electrical Review*, the apparatus consisting of a small platform of thin ferrotype iron or silver, having an opening for the reception of a thermometer bulb, and a small indentation or depression. In the latter, a very small quantity of the substance to be decided upon is melted, and, while still liquid, a thin platinum wire, bent like an L and fused into a glass float, is immersed in the liquid and held there until the substance solidifies. A thermometer is then inserted in the opening, and the whole apparatus plunged under mercury; the latter is gradually heated, the thermometer carefully watched, and as soon as the substance melts, the float rises instantly, the temperature being now noted. Stirring is by this arrangement unnecessary. The whole of the material is surrounded with mercury, and the attention can be concentrated on the thermometer, and the most accurate results thus obtained.

A New Method of Propelling Vessels.—Messrs. Samuel and John A. Secor, of Brooklyn, have devised a method of forcing gases against the water for the propulsion of ships. The system will soon be given a practical trial, the ship with which it is to be made having recently been launched. She now only awaits her machinery. The method employed, as stated by the New York *Electrical World*, consists in compressing a small quantity of air, which is then impregnated with petroleum spray. This is then exploded by an electric spark, and the large volume of gas generated is forced out at the stern. Petroleum being the fuel used, and only small quantities of it being required to form the explosive mixture, it is hoped to reduce the expense usually attending coal consumption to a minimum. It is expected that within a few weeks the boat will be ready for a trial.

Lightning Conductors in Philadelphia. — Prof. George F. Barker has recommended to the Public Building Commission of Philadelphia, as a protection to the 500-foot tower of the new City Hall from lightning, that two complete and continuous metallic conductors be placed on the tower from the base to the summit. He also suggested that the flagstaffs now erected on the pavilion be made to terminate in a number of sharp points. The metal of these points should have a high conducting power and a high point of fusion, not readily acted upon by atmospheric influences. The metal most available is said to be malleable nickel.

Sale of Machinery.—Messrs. Wheatly Kirk, Price and Goulty announce an important sale of wood-working machinery, boilers, lathes, &c., on Thursday, January 7th, at the large warehouse recently occupied by Messrs. Jackson and Graham, Ogle Street, Fitzroy Square, W.

"Impracticable and Unprofitable."—"The queerest thing about all this electro-motor business for railroads is the credit claimed for electricity," says the *Mechanical Engineer*. "This is an agent, as much so as the cable on cable railroads, and it would be quite as proper to call the cable the prime mover as it is to assert that electricity does the work. A steam engine does the work, for without it electricity would have no existence. Take away the steam engine and the railroad is inoperative, by electricity or anything else. As there is always a loss in transferring power from the source of it to an agent, the use of electricity on railroads is impracticable, and will be unprofitable, until it can be produced independent of steam."

We were not aware that anyone proposed using electrical propulsion on railroads in their proper sphere; but surely our contemporary will confess that locomotives are much more wasteful of fuel than a properly-designed stationary engine, which would be employed in connection with short tram lines, worked electrically?

Personal.—Mr. Jas. Swinburne notifies that he has now become connected with Messrs. Crompton's works.

The Queen has been pleased to confer the honour of Knight Commander of St. Michael and St. George on Col. Bateman-Champain, who is well known in connection with Anglo-Indian telegraph enterprise.

Telegraph Relays.—We shall publish in our next week's issue a paper on the above subject, which will be found of special interest to those engaged in telegraphic pursuits.

The Results of the Past Year.—We shall be glad to receive from electrical companies and firms brief reports of such of their work for the past year as they may deem it expedient to publish. At the same time, any intimation of work in hand and in prospect would form interesting items of news.

Seasonable Festivities.—The directors and staff of the Yorkshire District of the National Telephone Company gave a ball on Monday evening, the 21st ult., to the lady operators and other friends at the Technical College, Bradford. Amongst those present were Mr. G. A. Steinthal and Major W. H. Shepherd (directors), Major A. W. Lassen, Mr. and Mrs. Philipp, Mr. C. Philipp, Mr. J. C. Chambers (general manager of the company) and Mrs. Chambers, Mr. and Mrs. Michael Mullen, Mr. and Mrs. Walter Emmott (Halifax), Mrs. Frank Lumley, Mrs. W. J. Gray (Dewsbury), and Miss Marion Whitehead (Manchester). The following gentlemen acted as stewards:—Mr. F. Lumley, manager of the company's Bradford District; Mr. Ralph Mewburn, manager Leeds District; Mr. W. J. Gray, manager Dewsbury District; Mr. A. Ball, cashier, and Messrs. W. T. Davison and J. Holroyd, inspectors. The reception room, ball room and galleries were tastefully decorated with evergreens and drapery, whilst the band was screened from the ball room by a beautiful arrangement of foliage plants. Dancing commenced at 9 o'clock and was continued until 12 o'clock, when a supper provided by the Bradford Café was served. After supper several ladies and gentlemen went through a programme of songs and recitations which were much appreciated. After this dancing was resumed and continued until after three in the morning. Mr. Michael Mullen, shortly before the conclusion of a very enjoyable night, proposed a vote of thanks to the committee and to the givers of the ball for the entertainment so splendidly provided, a motion which was seconded by Mr. H. Storey and carried unanimously. Mr. Lumley, who responded in the absence of Mr. Chambers, said that he trusted this was the first of a series of such annual assemblies. The music was provided by Mr. Stocks Hammond's band.

The Palace of Delight.—Our readers will remember our note in the REVIEW for November 21st last respecting the contemplated Science and Art School and inaugural exhibition at Saltaire. We are now informed that Mr. Titus Salt has requested Mr. Holroyd Smith to put down an electrical railway in the grounds.

Obituary.—The Edinburgh correspondent of the *Times*, commenting upon the death of Sir George Thomson, who was a month ago elected to Parliament for one of the divisions of the city of Edinburgh, states:—"One of the most important of his public services was the prominent part he took in obtaining the transference of the telegraphs from private companies to the Government. The Edinburgh Chamber of Commerce was the first public body in the kingdom that took up the proposal earnestly, and that was due to the initiation of Sir (then Mr.) George Harrison, who was then and for many years one of its most active office-bearers. It was owing very much to his persistent zeal that the arrangement was carried out; and to him, therefore, the country is indebted indirectly for the benefits of the cheap and efficient telegraphy which it now enjoys."

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Royal Institution of Great Britain.—The winter programme in connection with the Royal Institution opens with a series of Christmas lectures by Prof. Dewar on the story of a meteorite, and the list of lectures down till Easter next includes such names as those of Dr. Ball, Astronomer Royal of Ireland, whose subject is the astronomical theory of the great ice age ; Mr. R. S. Poole, Mr. C. T. Newton, Prof. A. Gamgee, Mr. W. C. Roberts-Austen, Prof. W. Boyd Dawkins, Prof. Tyndall (who gives four lectures on light), Mr. Archibald Geikie, and Dr. Taylor, of St. John's College, Cambridge. The Friday evening meetings begin on January 22nd, when Prof. Tyndall discourses on "Thomas Young and the Wave Theory," and the programme of probable arrangements is one of sustained interest. The Royal Institution, as is well known, is an association of individuals who are attached to science and desirous to promote its advancement. It includes two laboratories for the promotion of chemical and physical science. In the physical laboratory the researches of Prof. Davy, of Prof. Faraday, and of Prof. Tyndall were conducted; while in the chemical laboratory Prof. Frankland made some of his most important researches in organic chemistry ; and more recently Prof. Dewar has conducted his spectroscopic researches, and his experiments relating to the chemistry of the electric arc and the condensability of gases. Both forms of the electric light, the voltaic arc and the magneto-electric spark were, indeed, first introduced at the Royal Institution by Davy and Faraday. In addition to the public lectures and the weekly meetings of the members, there are a model room, containing scientific apparatus of historical interest and of present use ; a library of about 50,000 volumes, a reading room for study, and a newspaper room. It only remains to be added that the institution is self-supporting and has never received any aid from Government.

Steel-Copper Electric Conductors.—It is many years since compound telegraph wires were introduced into this country from America and were tested experimentally, but, the combination being formed mechanically, the experiment resulted in failure. Since then a compound wire, consisting of copper deposited upon iron or steel, was tried in the States and many lines were run up with it and for a time it obtained extensive use ; but with us the compound wire has never secured a footing, failure having resulted, the principal faults being the uncertainty of the joints, and the "local action" setting up at any exposed place, causing the destruction of the wire. We have recently heard, says the *Mechanical World*, of a compound wire in which the relation of the two metals is reversed, the steel surrounding the copper. The wire is stated to be drawn from compound metal, consisting of a hollow ingot of steel filled with copper. The results of tests of a No. 8 wire so made are said to be very satisfactory, but in practice we should expect the old results to follow. A good and durable compound wire for telegraph lines is much to be desired, as decreased resistance could be obtained at reduced cost.

Electrical Conductors and Transmitting Power.—The paper which we publish by Mr. Thomas Whiteside Rae, C.E., contains many useful hints and thoughtful comments, but we cannot accept his deductions. M. Marcel Deprez would not look for a return of 70 per cent. of his initial power, even when working under far more favourable conditions as regards economy than appears to be the case on Mr. Rae's line. It might, on a first reading of the fourth paragraph, be thought that this gentleman referred to loss between generating dynamo and receiver only, but this will be found on further inspection to be erroneous, the difference being clearly that between the initial horse-power required to drive the generators and the available useful horse-power at the receiving end. It is a pity that what might have been an excellent paper should be seriously discounted by statements such as that to which we have referred.

Indian Patents.—Correspondence has taken place on this subject in the *Times*. Mr. Ernest De Pass, Fellow of the Institute of Patent Agents, wrote :—"From advices just to hand from my correspondents in Calcutta I am informed that, by a recent ruling, the Advocate-General has decided to admit applications for Indian patents within 12 months from the sealing of the British patent for the same invention. This will, no doubt, be a boon to inventors who, in order to secure Indian patents, had previously to this ruling to make application for the same within one year from the date of the British patent. In effect this gives to inventors a considerable extension of the time within which to apply." Subsequently Messrs. Abel and Imray wrote : "Referring to Mr. De Pass's letter in the *Times* of to-day, we would caution patentees against placing too much reliance upon the ruling of the Advocate-General as to admitting patent applications within 12 months from the date of sealing of the British patent. About 12 years ago precisely the same decision was come to by the Indian officials, and was acted upon for about two years, when, without the slightest warning, the Government reversed the decision, having come to the conclusion that it was against the meaning of the Act. The result was that several of our clients—and doubtless a number of other patentees—who had kept their Indian applications back relying upon the above decision—had their patents refused because their applications were filed after the expiration of 12 months from the date of the British patent, and although we made strong representations as to the unfairness of this action of the Government, no redress could be obtained. In view of these facts we would strongly advise patentees to continue the present practice of filing within 12 months from the date of the British patent until the alteration has been duly legalised by an Act of Legislature."

Tramways in the United Kingdom.—The development of the tramway system in every part of the United Kingdom, as shown by a Parliamentary return issued on Saturday week, is very remarkable and encouraging. The length of line now open for traffic, which 10 years ago was 94 miles, now reaches 656 miles, while the number of passengers has increased from 89 millions in 1876 to 283 millions last year. During the same period the gross receipts rose from £791,000 to £2,094,000, the working expenses amounting to £1,600,000, which, deducted from the former, leaves available for dividend the handsome surplus of £494,000. In Ireland 85 miles of line are opened for traffic, and 70 miles in Scotland. In the three kingdoms the local authorities hold 187 miles, and private companies 623 miles. Locomotive steam engines have been tried and discontinued in Edinburg, Bristol, Brighton, and Paris, while Glasgow, Manchester, Liverpool, Newcastle-on-Tyne, Northampton, London, Portsmouth and Plymouth are still dependent mainly, if not entirely, upon horse power. The new Blackpool tramway we have described, and it now remains to be seen whether sufficient enterprise is not forthcoming to make electricity indispensable for the economical working of tram lines.

Mr. Gladstone's Birthday.—Amongst numerous other congratulatory telegrams, Mr. Gladstone on his 76th birthday on Tuesday received the following :—"We offer you our heartiest congratulations upon the completion of your 76th birthday, and wish you and yours many happy returns, and pray that God may long spare you to continue to be a power for good.—Edinburgh Liberal Telegraph Clerks."—"Chester telegraphists congratulate Mr. Gladstone on the attainment of his 76th birthday, wishing him many happy returns of the day."—"Heartiest congratulations from the House of Commons and Parliament Street telegraph clerks."—"Glasgow telegraphists unite in forwarding best wishes and heartiest congratulations on 76th birthday, with compliments of the season."

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The Supply of Power.—The arrangement made between Messrs. Hornsby and Sons and the Jablochkoff Company for the lighting of Covent Garden Theatre appears to be deserving of more than passing notice. The former supply the latter with horse power, inclusive of engines, fuel, men, and incidental expenses for a given sum per month, the Jablochkoff Company thus being relieved of all responsibility up to the dynamo shafting. Such a compact should certainly be the means of securing both mechanical and electrical engineering of a high order, and this may probably be the reason why so few complaints have been heard respecting the electric lighting of Covent Garden during the season.

A New Light.—The Vienna correspondent of the *Standard* states that experiments are being made, at Professor Lieben's chemical laboratory, with a new gas light invented by Dr. Auer. A cotton wick, saturated with an incombustible metal solution, is introduced into the flame of an ordinary Bunsen lamp, the result being a light similar to the incandescent electric light.

Static Electricity.—"Spark" writes us as follows on this subject:—"Whilst running two Gramme machines for a period of 16 hours (commencing on Tuesday 15th ult., and stopping on Wednesday morning), with new leather belts from same line of shafting, towards morning a beautiful brush discharge was seen to escape to the ends of both machines, and on placing one's hand a good discharge was obtainable at a distance of nine inches. Will any of the readers of your valuable journal say if this is a usual thing, as I have been amongst machinery for a greater part of my life and have not noticed anything of the kind on leather belts before?" Our correspondent's experience must have been an exceptional one, as brush discharges of this kind are matters of every-day occurrence.

A Novel Gas Lighter.—In a well-known engraving and litho-zincographing establishment, where electric lights are largely used for photographing, it is stated that the gas is often lighted by simply holding a piece of wire from a speaking tube to gas burner, or from another gas pipe to gas burner.

The Sixpenny Telegram.—Mr. Geo. Bowes writes to the *Times*:—"If other people find the same inconvenience as I in the receiving of telegrams without the names of the senders of them being given, it is well to draw attention to the fact that much loss of time is caused by the omission. I am continually receiving messages which puzzle me much to find out from whom they emanate. The omission to give the name is no doubt due to the fact that there is no statutory obligation to send it, and there being no place for it in the official form, it is forgotten. To obviate this inconvenience the form of the message should be "From" as well as "To," and it should be made compulsory to give the surname at least. If the inconvenience I have found be general, the Act should be amended, as it is no use receiving sixpenny telegrams if they cost you shillings in time in endeavouring to find out who are the senders of them."

Swearing by Telephone.—The telephone is not an unmixed blessing, as many persons in America and several in Brussels have discovered—the latter recently. The Palace of Locken is in telephonic communication with the Opera House in Brussels, and it appears that her Majesty the Queen of the Belgians was the other day amusing herself by listening through the telephone to a rehearsal of the new opera by Litolff when she suddenly dropped the receiver and retired. The leader of the orchestra, in his anxiety to bring the chorus up to the degree of perfection he considered necessary, used rather strong language, forgetting for the moment that the telephone was present, and his words reached the Royal ears. The Queen made a formal complaint, and now there is much trouble at the Opera House.

The Telephone and the Telegraph.—The Bradford Chamber of Commerce has decided not to support the proposal from Major Shepherd that facilities should be granted for persons connected with telephone exchanges to have messages for any part of the world telephoned through to the postal telegraph offices. The Postal Committee, which had the matter under consideration, would not give its judgment against or in favour of the proposition. In a short time it was possible there might be extensive changes in the telephone, when it would be more reliable than at present, and then there might be a chance of the proposal receiving more attention.

Electric Lighting of Shops in Manchester.—The Manchester Edison Company is lighting Messrs. Paulden's extensive shop in Stretford Road, Manchester, with 300 incandescent lamps, each of 50 candle-power.

Messrs. Hope Brothers, Market Street, Manchester, have had their premises lighted internally with 100 incandescent lamps by Mr. H. Bury, who had previously lighted the exterior with arc lights.

Rochs Ahead!—See the new International Cable Company below.

In the Key of "A moll."—The Continental "Etève" Engine Company, set to the pretty tune of £450,000.

NEW COMPANIES REGISTERED.

International Cable Company, Limited.—Capital £1,000,000 in £10 shares. Objects: To establish telegraphic communication between the Azores, the West Indies, Canada, and the United States, from such point or points on the Coast of Great Britain and Ireland and the Continent of Europe as the company may determine, and between any point or points on the Coast of Canada, the West Indies, the Azores, the Bermudas, Central America, and the South American Pacific Coast, and from any point or points on the Pacific Coast, of Canada or America, to Japan and the Continent of Asia. Signatories (with 1 share each): G. Gordon Leycester Macpherson, 39, Lombard Street; Wm. Pope, 30, Finsbury Circus; E. G. Heathfield, 96 and 97, Palmerston Buildings; J. Jäcker, 1, Manor Park Villas, Streatham; T. H. Craven, 145, Evering Road, Stoke Newington; W. G. Gribbon, Norbiton, Surrey; G. B. Holroyd, Byfleet, Surrey. The signatories are to appoint the first directors, qualification 50 shares, or £500 stock; remuneration, £5,500 per annum. Registered 24th ult. by Bonner Wright Thompson & Co., 165, Fenchurch Street. Registered office, 39, Lombard Street, E.C., Otto Rochs, manager.

Continental "Etève" Engine Company, Limited.—Capital £450,000 in £1 shares. Objects: To purchase certain patented inventions relating to motive power, and to carry on the businesses of mechanical and chemical engineers, manufacturers of engines, workers and dealers in electricity, motive power and light, and any business in which the application of electricity or any other power may be useful. Signatories: A. D. Moll, 15, New Broad Street, 1,000 shares; E. J. Sheriff, 22, York Place, Portman Square, 500 shares; J. Lichfield, 61, Layspring Road, Leytonstone, 300 shares; J. Murphy, Wood Lane, Highgate, 10 shares; E. Fickling, Crouch Hill, N., 25 shares; R. Angus, 69, Holland Road, 300 shares; J. J. R. Humes, C.E., 18, Lilford Road, Camberwell, 200 shares. The signatories are to appoint the first directors, one of whom is to be Mr. Albert Douglas Moll; remuneration £150 per annum for each director, with £100 extra for the chairman. M. Jean André de Braam is appointed resident director in Paris at an additional remuneration of £300 per annum. Registered 29th ult, by Wm. Lichfield, 15, New Broad Street, E.C.

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OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Lancashire and Cheshire Telephonic Exchange Co., Limited.—The annual return of this company, made up to the 3rd September, was filed on the 23rd December. The nominal capital is £300,000 in £1 shares. 296,161 have been allotted and the full amount has been called and paid thereon. Since the date upon which this return was made up, the nominal capital of the company has been increased by the addition thereto of £100,000 in £1 shares.

CITY NOTES, REPORTS, MEETINGS, &c.

Gülcher Electric Light and Power, Company, Limited.

THE fourth ordinary general meeting of this company took place on Wednesday, December 23rd, at the offices of the company, 4, Coleman Street, E.C., Mr. Daniel de Castro, Chairman, presiding.

Mr. Russell Day, the secretary, having read the notice convening the meeting, and the minutes of the previous meeting, which were confirmed,

The Chairman said that on former occasions he had occupied a good deal of time in dealing with the various subjects affecting the company's interests, but the affairs of the company were now in such a position that the directors were able to tell the shareholders almost all they had to say in the report. But there were a few passages in the report which he wished to amplify, and which he thought the shareholders would wish to have explained more in detail. He proposed to run cursorily over the report, and then state a few facts from notes he had made. The first part of the report drew attention to the item of law costs, which was no doubt a serious item in the profit and loss account. At the date of the last-mentioned report serious litigation had commenced between Professor Crookes and the company. The company had brought an action against Professor Crookes for the return of £35,000, the amount of the purchase money for his incandescent lamp patents; and Professor Crookes had retorted by moving in the Chancery Division for a receiver and manager of the company's business. This was immediately followed by two Chancery petitions to wind up the company compulsorily, one presented by Mr. Henry Crookes, the manager of the Incandescent Lamp Department, the other by Mr. Norton, an original director of the company. Both petitions were dismissed, the latter upon the company undertaking to bring an action-at-law against Mr. Norton, which action was of course accordingly brought. In the last report the directors informed the company that the Crookes patents were in their opinion valueless; and that the Incandescent Lamp Department, managed by Mr. Henry Crookes (who drew a salary of £500 per annum), had always been carried on at a considerable loss. The result of the litigation, so far as the Messrs. Crookes were concerned, was that the company reassigned to Professor Crookes his various patents, and gave his son one quarter's salary, viz., £125. On the other hand Professor Crookes surrendered to the company £11,300 in fully paid up shares making (with £10,250 previously surrendered by him) a total surrender of £21,550 in fully paid shares of the company. He also returned £2,000 worth of Six per Cent Debentures, which he had received as part of his purchase money, and surrendered all claims to the position of consulting electrician to the company. It would be seen from the accounts that the result of these transactions appeared in the books of the company as a large loss of assets; the directors, however, considered that a substantial gain had been made. Two-thirds of the £35,000 purchase money, paid for patents which were valueless, had in one way or another been now returned, and the loss of the other third (which accounted for a large proportion of the total deficiency in the company's assets) was incurred by the original board when the contract with Professor Crookes was effected. On the other hand, the return of the £2,000 worth of debentures, and the reduction of the salaries' list by £1,050 per annum, were substantial gains to the company due to the position which, with the shareholders' consent, the board took up last autumn. Moreover, the annual loss incurred in the incandescent lamp department alone was very large indeed, and far exceeded the cost of the litigation which had enabled the directors to shut up that department altogether. With regard to the agreement with the original promoters, it was not yet completed. The company had performed its part, but the promoters had still to surrender about £6,000 worth of fully paid-up shares in order to complete their part. The company had now waited two years to give the promoters every chance of carrying it out, but as no move had been made for some time by the promoters, the company intended, under the advice of counsel, to take immediate steps to enforce the performance of it by them. It would be in the memory of those shareholders who attended the general meeting last December, that a resolution was passed authorising the directors to treat certain sums amounting together to £1,223 15s. 3d. as claims only, and not as debts. These claims were chiefly for fees alleged to be due to the old directors, and for a balance due to their solicitors. With the exception of £164 18s. 2d., claimed by the late chairman as unpaid balance of his fees, and for which he was now sueing the company, all the above claims had been disposed of upon terms considered satisfactory by the directors. The sale and hire of dynamos and lamps during the 12 months ending September 30th, 1885, amounted to £10,099 11s. 8d.. whereas the proportional sale and hire during the preceding 12 months amounted to £7,200, or thereabouts. This scarcely represented the progress which the company's business had made. A considerable increase of business set in towards the end of August last, which was developed throughout September, and had been increasingly maintained since; and the orders in hand at the present moment were quite as large as the company with its present capital could conveniently undertake. There was also a reasonable prospect of a still further increase of business not only in the direction of electric lighting, but of the manufacture of dynamos for the electrolytic deposition of metals, to which branch considerable attention had been given of late. The company had orders from the Government for army and navy purposes, and from all kinds of manufacturing establishments. The most important order perhaps was that of Sir Wm. Armstrong for Elswick works. The adoption by the Elswick Company of the Gülcher Company's system of lighting was a sufficient guarantee in itself of its excellence and efficiency. For the first time since the formation of the company a manufacturing profit could be shown, and although it vanished as compared with the heavy standing and other expenses of the year, it compared favourably with the manufacturing loss which had to be admitted in the last balance sheet. Many of the expenses were exceptional, and were not likely to recur. Exclusive of the charges for depreciation of patents, &c., these expenses ought, in the opinion of the directors, not to exceed £2,500 in the ensuing year. On the other hand, the permanent staff at the works (whose salaries, exceeding £600 per annum, were included in the item "wages" in the manufacturing account) would not be any larger though the business should increase threefold, but assuming that the turnover should only be doubled (which the directors did not think at all improbable) the margin of profit to be carried to the credit of profit and loss would be increased by the addition of £600 from that cause alone. No dividend could be paid until the losses had been made up, and it might therefore become expedient at a future time to reconstruct the company. In conclusion he begged to say that he now resigned the chairmanship of the board, and that there was a seat on the board at the disposal of the proprietors. He retired by rotation, and did not offer himself for re-election, as the onerous nature of the work involved seriously interfered with his professional business. He begged formally to move the adoption of the report and accounts.

Major Cotton seconded the motion.

Mr. Foulsham asked if the company did not manufacture incandescent lamps, how was it that it was erecting incandescent installations?

The Chairman replied that the company supplied Gülcher dynamos and bought and supplied Swan lamps at a profit.

Mr. Murray said he did not quite understand the item of £10,848. He also asked why the manufacturing account and the profit and loss account were kept separate.

The Chairman explained that the accounts had been approved and were drawn up in the usual way by Messrs. William Edwards, Jackson and Browning, F.C.A., and he believed that it was the proper form of account for a manufacturing business.

In answer to a shareholder, the Chairman explained that the arrears on the two last calls amounted to about £2,500. Only a small portion of this amount was considered bad, but certain shares, which were held by persons whose addresses could not be found, would after a time be forfeited unless the arrears were paid.

Mr. Hidden and other shareholders having asked a variety of questions as to calls, and suggested a reconstruction,

The Chairman said that the question of reconstruction had been for some time under the consideration of the board, and that they thought they saw their way to proposing a reconstruction shortly upon the basis of writing off £3 10s. or £4 per share of the capital as lost. If they wrote off £3 10s. per share there would be assets (independently of the value of the Gülcher patents, whatever that might be, and independently of anything for goodwill), more than equivalent to the 30s. per share which would remain paid up. The capital would then consist of £30,000 or thereabouts, for which there would be more than £30,000 worth of stock, plant, material, book debts, cash, and bills. A dividend could then be paid when earned, as all the losses would have been written off, and with a dividend being paid, new capital might be asked for if required. It might perhaps be, and he believed it was, the opinion of some of the shareholders that it would be better to write off £4 than £3 10s., as the shares would still be intrinsically worth the same money; and of course the same sum of money declared as divided on £20,000 capital would be larger and much more attractive than if declared upon £30,000. He agreed to this proposition, but in his opinion it was the duty of the board simply to tell the shareholders what amount would have to be written off in order to make the share capital equal to the value of assets of the company as a going concern; and to do that

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it would be sufficient if £3 10s. per share were written off. It would remain, however, for the shareholders when the scheme was ripe and placed before them to decide for themselves whether their shares should thenceforth be 30s. shares or £1 shares only—in each case, of course, fully paid up. Having regard to the large amount of work in hand and in prospect compared with the small amount of working capital at the disposal of the board, it was resolved to authorise the directors to raise, as they might require it, a sum not exceeding £5,000 by the issue of debentures. Part of this was offered by shareholders present, and he had no doubt from his knowledge of the body of shareholders that that sum could be easily raised among them—in fact, more easily than £10,000 which had been raised two years ago, and since paid off.

The report and accounts were then unanimously adopted, and Messrs. Mountain and Fricker were re-elected directors.

The Chairman said, in answer to questions from one or two shareholders, that it had been his intention to retire from the board at this meeting and to decline re-election, as he considered that he had practically finished the work which he undertook to do two years ago, and he thought that the company could now go on very well without him. He had, however, received so many and such pressing requests from shareholders not to retire at present that he felt constrained to comply so far as he could with their wishes. If, therefore, the general body of shareholders thought that his work was not yet completely finished, he would consent to be elected once more, and he, therefore, placed himself in their hands and at their disposal.

Mr. Foulsham moved, and Mr. Woodly seconded, Mr. De Castro's re-election, and this was unanimously carried.

Messrs. Wm. Edwards, Jackson, and Browning, the auditors, were re-elected, and a cordial vote of thanks to the chairman and directors then terminated the proceedings.

Eastern and South African Telegraph Company, Limited.—This company announces that the coupons due on January 1st on its 5 per cent. mortgage debentures, will be paid on presentation at the offices of Messrs. Barclay, Bevan & Co.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 25th were £2,062, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1885.

15455. "Dynamo-electric machines." J. C. Mewburn. (Communicated by W. Main.) Dated December 16. (*Complete.*)

15484. "Electricity." J. Swinburne. Dated December 17.

15535. "Dynamo-electric machines." R. P. Sellon, J. S. Sellon. Dated December 17.

15539. "Telephone transmitters." C. E. Allen. Dated December 18. (*Complete.*)

15558. "Electric bell circuits and indicators." H. M. Townsend. Dated December 18.

15559. "Electric bell pushes, pulls, and similar contacts." H. M. Townsend. Dated December 18.

15617. "Electrical switches." H. B. Bourne, H. R. F. Bourne. Dated December 19. (*Complete.*)

15652. "Apparatus for obtaining rotary motion from electric currents." E. O. Wehrle. Dated December 19.

15658. "Electrical switches." B. M. Drake, J. M. Gorham. Dated December 19.

15674. "Secondary batteries, or electrical accumulators." P. Higgs. Dated December 21.

15714. "Galvanic batteries." A. R. Upward, C. Pridham. Dated December 21.

15817. "Apparatus for transmitting articulate speech or other sounds by electricity." A. F. St. George. Dated December 23.

15869. "Primary battery." V. Blumberg, A. Blumberg, N. Frere. Dated December 24.

15926. "Electrical toys." J. H. Galloway, W. Banks. Dated December 28.

15956. "Electric batteries and apparatus." W. S. Whitter. Dated December 29.

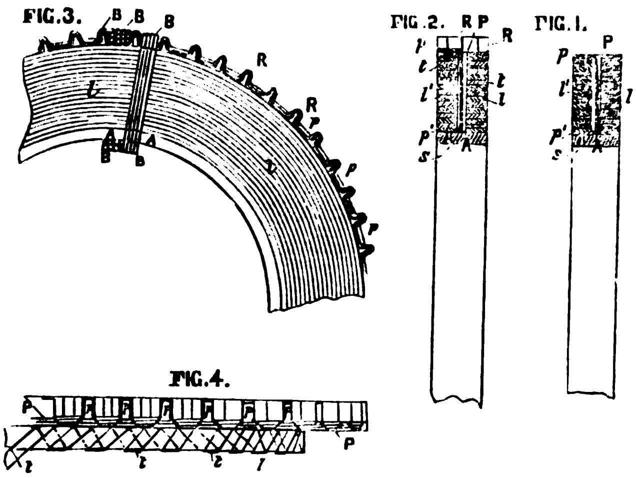
15967. "Electric transmitting telephones." J. T. Dempster. Dated December 29.

15987. "Pneumatic cash carriers." W. G. Davis, W. M. Hinman. Dated December 29. (*Complete.*)

15988. "Electrolytically refining copper and making sulphuric acid by electrolytic action." W. Elmore, A. S. Elmore, H. Barrett. Dated December 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

13810. "Improvements in the construction of armatures for dynamo-electric machines." F. Wynne and R. P. Sellon. Dated October 18. 6d. In figs. 1, 2, 3 and 4, A shows the foundation ring, which is fastened in any suitable manner to the driving shaft; l, l^1, show two spiral cylinders of iron strip wound upon the "foundation ring," between which the disc, P, is placed, this disc is corrugated, and the internal periphery is bent over at right angles at the point, p^1, and rigidly fixed to the "foundation ring," A, by means of suitable screws or rivets, s; the outer periphery is also slotted and bent over at the point, p, alternate flanges



of the disc holding down the two spirals, l and l^1. In figs. 2 and 4, the iron strip, l, is shown served with paper, tape, or other convenient insulating material, t, t, one of the spirals being here shown in course of winding. The corrugations of the disc, P, and the positions occupied by the bent flanges, p, p, holding down the iron strip, are here clearly shown. In figs. 2 and 3, the projecting portions, R, R, R, are also shown, surrounding on the outer periphery, the spiral cylinders, l and l^1, and forming a support for the wire bobbins, B.

13879. "Improvements in the construction and working of electric accumulators, and in apparatus or means therefor." J. S. Williams. Dated October 20. 1s. 3d. By means of the improvements the inventor increases the storage capacity, reduces the weight and bulk, obviates local action and short circuiting and the destruction or oxidation of the terminals or connections of the elements or the displacement of them, also the destruction of the diaphragms or supports for separating or maintaining the active elements in their proper relative positions.

1885.

311. "Improvements in electric telegraphic apparatus for transmitting and receiving signals on board ship or other places." J. S. Gisborne. Dated January 9. 8d. Consists of a transmitter having the required orders indicated on a dial, which transmitter is connected by an electric cable with an indicator having also on a dial corresponding orders to those on the transmitter. This cable contains a separate wire for every "order" also a wire common to any one of the "orders" of the series for completing the circuit between the transmitter, indicator, and battery, also a wire connected with the reply gong in the transmitter.

376. "An improved electric annunciator." F. Walker. Dated January 10. 8d. The inventor employs a weight, which being held in a given position, causes the electric circuit connecting the bell with the annunciator to be broken; and, upon said weight being released, it resumes its normal position, and making electrical contact, rings the bell in connection with the annunciating device or contrivance aforesaid.

597. "Improvements in apparatus or appliances for connecting telegraph cables between ships and the shore or themselves." R. Atkin. Dated January 15. 8d. The inventor employs a hollow protecting tube for the telegraph or telephone cable to pass through. This tube may lead to the mast head or be fitted to the bows. When it is fitted to the mast, the inventor makes the mast proper tubular and steps it on the between deck beams; within this tubular or hollow mast he places another tubular mast which is stepped and free to rotate on a spindle secured to the kelson of the ship, above the spindle and free to turn with the inner mast there is a platform to carry a winch for the cable, telegraph apparatus, instruments and the like necessary appliances. A convenient distance above the platform there is an aperture in the rotating mast through which the cable passes and is carried up through the tube to the top thereof where it is carried round or through a sheave and thence to the shore, ship, or other place with which it is desired to make communication.

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1101. "Improvements in telephonic and telegraphic apparatus." J. STEPHEN. Dated January 26. 8d. Has for its object to provide a switch table which may either be operated by an attendant at the central station or exchange, or automatically by the subscribers themselves.

1184. "Improvements in the regulation of electrical circuits and in appliances connected therewith." D. L. SALOMONS. Dated January 27. 8d. Consists in the introduction, as a regulator, of an electrical motor, or electro-dynamo machine, employed as a motor or as a generator developing a counter current between the forward and return "leads" or wires of a main working circuit, or as it is usually termed "in parallel."

6206. "Improvements in telephone transmitters." A. M. CLARK. (Communicated from abroad by the Long Distance Telephone Company (Incorporated), of New York.) Dated May 20. 4d. The object of the invention is to provide a light portable telephone transmitter which may be readily held in the hand while carrying on telephonic communication. Fig. 1 is a front elevation of the improved telephone transmitter. Fig. 2 is a longitudinal section of the same. Fig. 3 is a transverse section taken on line *x*, *x*, in fig. 2. The invention consists essentially in a granulated semi-conductor, such as granulated or coarsely powdered carbon, maintained normally under compression; also in apparatus for utilising such a semi-conductor in a transmitting telephone. The telephone has a diaphragm cell, I, provided with a mouth piece, J, of the usual form, which clamps the diaphragm, K, in the cell. In the centre of the diaphragm cell is formed a cylindrical cavity, L, in which is placed an elastic rubber tube, M, having at opposite ends the conducting plates, N, N¹, which together with the said elastic tube, M, forms a chamber, O, which is filled with granulated carbon. In the body of the diaphragm cell, I, at diametrically opposite points are placed metallic nuts, P, P¹, which are in electrical communication with the plates, N, N¹, and which receive the pivotal screws, Q, Q¹, passing through spring arms, R, R¹, attached to the handle, S, and form the pivotal support of the transmitter as well as the electrodes by which the current is introduced into the instrument. The diaphragm, K, carries a stud, *n*, which presses upon the centre of the conducting plate, N, and in a cavity formed in the back of the diaphragm cell, I, is secured a cross bar, *o*, provided with a central adjusting screw, *p*, which bears upon the centre of the conducting plate, N¹, and is employed to maintain or vary the normal pressure upon the granulated carbon contained in the elastic tube, M. The handle, S, of the telephone transmitter is made tubular to receive the double conductor, T, containing the wires, *m*, *m*¹, communicating with the curved arms, R, R¹. The current arrives at the granulated carbon contained in the elastic cell, M, from one pole of a battery, U, through the wire, *m*¹, curved arm, R¹, screw, Q¹, and nut, P¹, wire, *q*, and plate, N¹, and passes from thence through the plate, N, wire, *r*, nut, P, screw, Q, arm, R, and wire conductor, *m*, to the primary wire of the induction coil, V, which is connected with the remaining pole of the battery; one end of the secondary wire of the coil goes to the ground, the other end being connected with the line. Sounds made in the vicinity of the mouth piece, J, vibrate the diaphragm, K, and the diaphragm acting through the stud, *n*, exerts a greater or less pressure upon the granulated carbon contained in the elastic cell, thus altering its conductivity and producing fluctuations in the current by which speech is transmitted along the line.

FIG. 1.

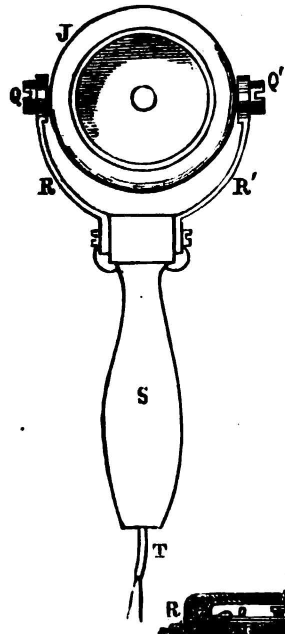
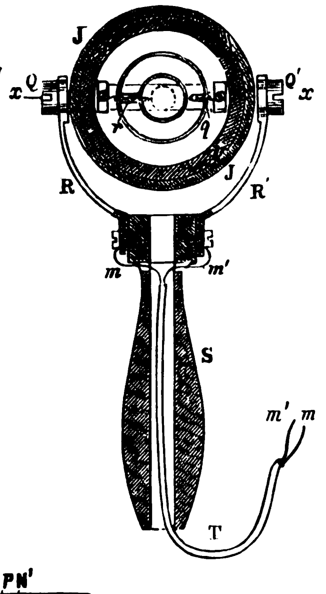


FIG. 2.



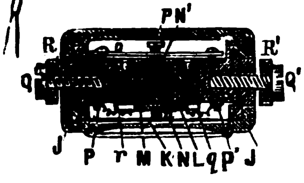


FIG. 3.

CORRESPONDENCE.

Secondary Battery Patents.

Our attention has been called to a paragraph in your issue of 19th ult., relating to the action which was brought by this company against Elwell-Parker, Limited, in Vice-Chancellor Bacon's Court for the infringement of a portion of one of Mr. Sellon's patents which is the property of this company, and also to an advertisement of Elwell-Parker, Limited; and as the public may form an erroneous impression from these publications we write to say that the above action was settled by Elwell-Parker, Limited, consenting to a perpetual injunction and taking a license to manufacture (subject to certain limitations) accumulators under the patents of the Electrical Power Storage Company on payment of royalty; a reciprocal arrangement also existing for the Electrical Power Storage Company to use, under royalty, should they at any time so desire, the Elwell-Parker patent.

Electrical Power Storage Company, Limited.
H. PELL, *Secretary*.

December 23rd, 1885.

A Curious Contact.

Apropos of the paragraph in your "Notes" columns entitled a "Curious Disconnection," it may be interesting or, to say the least, amusing, if we relate the cause of a fault which has within the last few days come under our notice.

The proprietors of one of our largest hotels here called us in to elucidate a mystery which had sorely perplexed the entire staff. The trouble which they complained of was that the indicators belonging to two of the bedrooms were continually dropping and the bell therefore an intolerable nuisance.

On examination it was found that the line wires and return connecting these two rooms passed together through one of the rooms and as the boarding in one part evidently had been difficult to remove it was plain that resort had been had to the gimlet and the wires then threaded longitudinally through that section.

Now it so happened that one of the bedstead legs stood on this identical board and this particular leg for some reason, perhaps best known to itself, having lost its castor, it will readily be imagined that the weight and moving about of the bedstead caused the ragged bolt to break through the *thin* wooden covering which the boring had left. Having broken through the wood and reached the wires, the G. P. covering soon became defunct and the sequel will be at once obvious to your readers.

C. W. and A. E. Cotterell.

Birmingham, *December 29th*, 1885.

Archimedes Redivivus.

There once did lay without the walls of modern Syracuse,
A tramcar, worn and shaky by long continued use;
Archimedes saw in it a means of using force
Extracted from the elements, thus dispensing with the horse;
"The power is small," the sage explained, "it matters not to me,
With a system of my levers I will double it, you see,
And so defy all Nature's laws, and scientific men
Shall hide in very shame their heads, and throw away the pen.
Upon my spindle, four horse-power; thro' my lever, eight;
Sixteen on the axle, when the speed's at lowest rate;
I don't admit the friction, weight, nor wear and tear,
For traction up an incline I have no need to care;
I may confidently tell you, thro' the scientific press,
That before I 'LEAVE HER' I shall score a great success."

Hiero.

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Re Electrical Formulæ.

In reply to the remarks of December 19th, signed "Gnan," on the figure 13·59 used by me as Dr. Matthiessen's for the resistance in B. A. units of one mile of pure annealed copper wire $\frac{1}{16}$th inch diameter, 15·5° C., I beg to say that I took it from Clark and Sabine (pages 7 and 8, Jenkins's Table of Standards). Having now looked through a number of authorities I find a majority of statements of Matthiessen's standard in accordance with the correspondent's (f. i., Culley, Kempe, Munro and Jamieson) curiously enough in each case different temperature and dimensions used. I remark that Kohlrausch (1881) quotes Matthiessen with a still lower figure than the above; also that a table published, I think, in 1884, by *The Electrician*, of the Board of Trade wire gauge, has been worked out on the basis of the 13·59 being Matthiessen's figure.

Assuming that my standard figure is too low by the amount in question, then my table of κ and the various figures derived therefrom throughout my articles correspond to copper of 97 (or nearest 97·2) instead of 95 per cent. conductivity.

F. V. Andersen.

I realise with pleasure from Mr. Moon's last article great progress in our discussion. It has hitherto been exceedingly difficult to find a connection between Mr. Moon's remarks and their subject—my paper "On some practical electrical formulæ." He has never tried to prove that any of the formulæ were wrong, and yet he has some objections to their use, and spends column after column in trying to show that there should be something wrong in the matter somewhere; something which he has not yet himself got hold of, but which he evidently believes must turn up by-and-bye, if we only continue long enough to get everything tried. He will not understand that by striking at the wrong formula he can finish the matter in a few lines, whereas by loose assertions, not supported by facts or proofs, he will never shake an $\frac{a}{b} = c$. Last week's contribution, however, marks an improvement; Mr. Moon makes an indirect attack on my formula for electrical merit of dynamos, saying that it will introduce the absurdity that in a certain case, which (alas!) he does not specify, "the figure of merit is increased by making the machine less efficient and less economical." This declaration I welcome as *le commencement de la fin* of my discussion with Mr. Moon. The formulæ in my paper having been established by ordinary algebraic reasoning, I will now ask Mr. Moon to, in a similar way, prove that any one of them is wrong, or that something contradictory is correct. For if formulæ IV., VI., and VIII. in my paper are correct, then it is a physical impossibility that a case such as the one Mr. Moon alludes to can exist.

To go through a communication from Mr. Moon for once, I shall now quote his last statements one by one, and add a brief remark to each.

1. "It is useless for Mr. Andersen to plead that his formulæ are for use *only* in the construction of dynamos."

The small word in italics is Mr. Moon's.

2. "From the preceding it is obvious that Mr. Andersen then proposed to use this particular quality of dynamos as a general criterion by which the values of machines of different types might be determined."

Insert between "values" and "of": "in regard to electro-magnetic construction," and the statement will be fairly correct.

3. "But is it at all probable that dynamo makers will consent to have their machines valued by this one quality alone?"

I will leave to Mr. Moon or the readers to establish a connection between a coefficient of electrical merit and the consent of the dynamo makers, and remark that we might strike out the word "alone," since we ought certainly to test also the mechanical merit, ask the price, and several other little items. At the present time there might, indeed, be makers who would have no objection to know the electrical merit of their dynamo.

4. "The fact that $F \frac{w\,a}{w\,a + w\,m}$ of a machine was large would neither ensure that it would perform work cheaply nor that it was reliable."

Read the remark against "alone" in the preceding; then, will Mr. Moon kindly illustrate this statement with an example?

5. "His" (Mr. Andersen's) "expression $F \frac{w\,a}{w\,a + w\,m}$ would be a maximum with a small armature moving in a strong magnetic field, and performing little or no external work."

The size of the armature cannot be inferred from the expression; the "little or no external work" is a fallacy, as a glance at the expression itself will show to anybody who is familiar with the theories of dynamos. Will Mr. Moon kindly give an example?

6. "Several of the recent and most efficient machines rely upon a weaker field and a comparatively large armature."

Hard to say: the hope of these dynamos, for high efficiency is built upon sand, for the proportionate waste in the armature equals $\frac{\kappa\,a}{F\,V}$ (κ = ohms × $\frac{\text{section}}{\text{length}}$ of conductor, a = ampères per square inch do., V = velocity). If Mr. Moon by "large armature" indicates comparatively high velocity, this has nothing to do with the point in question. But there is just a tendency to work the modern dynamo at moderate velocity. It must, therefore, rely on a *strong field*, both for power and efficiency.

7. "I must again insist that machines of different types must perform work at the same rate while their comparative values are being determined."

We should wrong the makers by such a way of proceeding. Some machines would burn down while others were running with half their normal load. The rule must be as I have said in my paper, to load all machines so that they perform work at a standard (maximum, safe) temperature.

8. "In this case the figure of merit is increased by making the machine less efficient and less economical."

A description of such a case is required.

9. "To me it is evident that there is a certain proportion between the strength of field and the amount of conductor on the armature which would produce the most economical result, and that either an increase or a decrease of the effective strength of field would produce a result less economical."

It is quite evident to me that this theory as it stands expresses an absurdity. Draw a comparison between a dynamo and a galvanic battery: What is the maximum economical electromotive force per couple of electrodes, other things being equal?

10. "This term" (figure of merit) "in telegraphy refers to sensibility, and not to efficiency or economic value."

A glorious distinction. Does Mr. Moon want this argument taken seriously?

In conclusion, I remark that I have undertaken the task of analysing the whole of one of Mr. Moon's letters, on purpose to relieve myself of the duty of further discussing with him the present subject in general, as I think it will now be evident to the readers what a waste of energy that means.

Only in case he takes to facts shall I again take notice of his remarks. In criticising the conclusions to be drawn from formulæ for use in practice, he appears to me to work too much like one of those recent dynamos which rely upon a weak field and a large armature, *i.e.*, on lack of force and abundance of matter, which cannot be efficient.

F. V. Andersen.

December 28th, 1885.

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVIII.—No. 424.

CABLE COMPANIES' RESERVE FUNDS.

THIS is an age of co-operation, and the principle is utilised for the promotion of objects which are to be deplored as well as of those which are commendable. The latest form of co-operation which has come under our notice can scarcely be said to be inherently bad, though from a rash administration it may possibly lead to unwise courses. The shareholders of the Anglo-American Telegraph Company—or at least a section of them—have formed themselves into an association for the protection of their interests; and this fact, as affording evidence of a determination on their part to understand the affairs of the company of which they are members, is a subject for satisfaction, for the lack of watchfulness over their doings has often led directors to adopt measures which would not generally commend themselves. There are many ways in which an intelligent interest in the business of a company displayed on the part of the shareholders may be helpful to the directors, who, generally speaking, are ever ready to give a willing ear to whatever criticisms or advice shareholders may have to offer. But it is too often the case that the remarks of the would-be critics are not intelligent; frequently they are prompted by the bitterness of disappointment, and are not based upon a knowledge of the working of the concern to which they relate. This has in no case within our experience been more frequently noticeable than at the general meetings of the various cable companies, whose shareholders have shown an extraordinary inability to comprehend that a reserve fund of apparently large proportions is absolutely necessary to the stability of the company, is a safeguard against collapse, which else might at any moment occur, and is an element which tends to give the stock of the company a high value in the market.

Excellent, therefore, as the general objects of the Shareholders' Association which has supplied us with the motive for our remarks may be, it is matter of regret that the point upon which its promoters most strongly rely as the *raison d'etre* of its existence should be that of staying the periodic increase of the reserve fund. Probably no one knows better than the directors and those who advise them, what length of time the existing cables may be expected to live, and it is their business to be prepared to replace them when they have from any cause become incapable of further use. It is possible that the Anglo-American Cables will last many years yet; but it must not be overlooked that the dangers which beset these cables are greatly in excess of those to which almost all other forms of property are subject, and it is a contingency not altogether impossible of occurrence that within a twelvemonth the directors may find themselves called upon to make a very considerable outlay either in repairs or in renewal. Then, the lives of the cables must end some day, and, notwithstanding what has been said to the contrary, it is pretty safe to say that the present reserve fund, £850,000, will not be sufficient, nor will it be nearly sufficient, to purchase and lay two fresh cables. And it must not be forgotten, too, that when the time comes to put down these new cables, if there be not more than enough for the purpose in hand, the Company has to begin again at the very beginning, and, whilst rebuilding its reserve fund, who is to guarantee it a total immunity from the necessity for further outlay? It has been said that the cables now lying in the Atlantic are more than enough for the traffic, and that even should one or both the Anglo-American Cables break, there would be no immediate need to repair them, as, in consequence of the pooling arrangements, the Company would suffer no diminution in its receipts for at least a twelvemonth. But surely the shareholders have not forgotten that last year for a space of months every cable but those owned by the Anglo-American Company was interrupted, and but for the accidental good fortune of this Company there would have been no receipts to pool. The directors best know the state of their cables, and, if anybody knows, they undoubtedly do, at what point the additions to the reserve fund may with safety be discontinued. That they believe there is no immediate danger of any large demands upon the fund may be gathered from their decision last year to appropriate to it a smaller sum by £50,000 than had for some time been their practice; and this should reassure the shareholders as to the increasing value of the property which they hold.

If the new Association studies this question with the intention of seeking the permanent interest of the company and ignoring transitory personal considerations, it will undoubtedly recognise the wisdom which has secured for the company so strong a backbone, and will abandon its present position in this particular respect. There are other directions, however, in which the energies of its committee may be usefully employed, and the gentlemen who have been so earnest and persistent in the efforts which have led to its formation may be assured of the good wishes of all holders of shares in joint stock companies if they will devote themselves to bringing about an alteration in the existing articles of association of the company, and a more discriminating surrender of proxies by the vast body of shareholders who do not attend the general meetings. If they can succeed in this they will necessarily secure what they seek, and what they are most certainly entitled to, *i.e.*, more power in regard to the spending of the money they have contributed.

USE OF WATER-POWER FOR ELECTRIC LIGHTING.

THE Falls of Montmorenci, seven miles from Quebec, have an almost perpendicular fall of 262 feet, and have for many years been utilised as a motive-power for some lumber mills near their base. Everything is now ready for the introduction of electric lights into Quebec, and the electricity will be generated by water-power from

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these falls. The writer (Ralph S. Tarr, in the New York *Electrical Review*) visited the works in August last in company with their owner.

The water is conducted from the river through a sluice-way to the edge of a precipice, where it is collected in a tank. This tank is tapped in two places, one opening into a tube which leads to the works below; the other through a waste sluice. The latter leads from the upper part of the tank just above the level of the tube, and as long as water runs down this sluice it is a sign that the tube is filled. The amount of water that runs into the tank can be regulated by lessening the quantity of water which supplies the power in the saw-mill, for this supply is tapped from the regular sluice nearer the falls.

The tube leading to the works has an inside measurement of 4½ feet at the top and gradually diminishes to 24 inches at the base. It is built of three-inch wood at the top and of one quarter inch boiler-plate iron for the lower three-fourths of the length. It is calculated to last for 50 years. So great is the pressure that the water actually oozes out through the lower portion of the wooden part of the tube. There is a weight of 165 feet of water at the base of the tube, where it will turn a turbine wheel at such a rate as to furnish 800 or 900 horse-power. The tremendous pressure exerted by this column of water is well shown when one turns on a hydrant which throws a stream of water with such force as to make a deafening roar as it strikes the side of a neighbouring building. There are eight of these hydrants at different parts of the lumber yard, and no building is out of reach of a heavy stream of water. On the roof of the main building an iron tube, perforated with holes, is run along the ridge-pole so that in two minutes the whole roof can be flooded.

The large conducting tube is led into the basement of the building and the water can be turned into a 24-inch iron turbine wheel with eight buckets. The pressure is sufficient to turn the wheel at the rate of 610 revolutions per minute. A perpendicular steel shaft turns two heavy cogs, which transfer the motion to a horizontal shaft making 900 revolutions per minute. On this horizontal shaft there are eight pulleys, four feet in diameter, which are connected with eight dynamos on the floor above. Enough electricity will be generated to supply 800 arc lamps in different parts of the city. The turbine is to be kept at the constant velocity of 610 revolutions per minute; this is regulated by a governor connected with a gate which increases or decreases the amount of water flowing into the turbine. To prevent the water in the tube from freezing during the day, when the dynamos are not working, the water will be allowed to run through a gate at the end of the tube, thus keeping up a constant circulation.

Everything connected with the works is constructed for durability, and is much stronger than is really needed. There are no belts, and the power is conducted to the dynamos almost directly. The ends of the horizontal shaft rest upon Babbitt metal, and to prevent heating the support of the shaft is hollow, and will be filled with a constantly flowing stream of cold water. The water for turning the turbine is carried three-quarters of a mile from the falls to the works.

The works were not in operation when the writer visited them, but the lumber mills have been lighted by electricity for some time. The power for this purpose is furnished by an 8-inch turbine (probably the smallest in the world), running with a force of 60 horse-power, and connected with a dynamo that can run 20 lights. Only nine lights are in operation, and are much more satisfactory than those at present used in Quebec.

Electrical Formulæ.—We have received from Mr. Moon a reply to Mr. Andersen's last letter, but too late to be inserted, owing to its extreme length, in our present issue.

ON THE LAW OF THE ELECTRO-MAGNET AND THE LAW OF THE DYNAMO.*

By SILVANUS P. THOMPSON, D.Sc., B.A.

It is remarkable, considering the vast amount of research that has been made, that authorities in physics are in so little agreement as to what the law of the electro-magnet is. Upon the one topic that is all-essential to the electric engineer the professed physicist is either silent, or gives mathematical rules that are hopelessly wide of the observed facts, and based in most cases on no consistent theory. The expressions given by Weber † for the relation between the magnetising force and the induced magnetism are an exception; but they are unmanageable in the extreme, and have led to no useful results. The expression given by Lamont ‡ is also based on a certain consistent theory, but it appears to be entirely unknown both to physicists and to electric engineers, and is to be found only buried in the depths of Lamont's own treatise, The two mathematical formulæ which are most often given in treatises on physics as representing the relation between the magnetising current and the induced magnetism of the electro-magnet are the following:—

Lenz and Jacobi's Formula.—According to the experiments of these early investigators (1839), the magnetism of the electro-magnet is simply proportional to the strength of the current and to the number of turns of wire in the coil. This may be written as

$$m = k\,\mathrm{S}\,i,$$

where i is the strength of the current, S the number of turns in the coil, k a constant depending on shape and quality of iron, and m the strength of the pole. Joule (1839) showed this rule to be incorrect, and that as the iron became saturated, m ceased to be proportional to S i.

Müller's Formula.—Müller gave an expression of the form:—

$$m = b \tan.^{-1} \frac{\mathrm{S}\,i}{a},$$

where b and a are constants, depending on the form, quantity, and quality of the core and on the form and disposition of the coils. Very similar formulæ have been used by Von Waltenhofen, Dub, Cazin and Breguet. They are purely empirical, fail to represent the facts with accuracy, and have, moreover, the defect of not lending themselves conveniently to use in the equations of electro-magnetic motors, dynamo-electric machines, and other kinds of electric machinery.

More recently another formula has been coming into use, and is known—for reasons which will presently appear—as Frölich's formula: it is written

$$m = \frac{i}{a + b\,i},$$

where a and b are again constants, b being the reciprocal of the maximum value of m. This formula, like the preceding, is a perfectly empirical expression not based in itself upon any physical theory, but it accords with the observed facts of the electro-magnet better than any of the preceding formulæ. Frölich, who in 1878 was using merely Lenz and Jacobi's formula§, appears to have adopted this expression in 1880‖, in consequence of the experiments which he had made with dynamo machines. A similar formula had been used 25 years before by Robinson ¶ to express the lifting power of an electro-magnet, and similar

* Read before the Physical Society, 14th November, 1885.

† Weber, *Elektro-dynamische Maasbestimmungen*, p. 572. See also Maxwell, "Electricity and Magnetism" (2nd edition), vol. ii., p. 78.

‡ Lamont, *Magnetismus*, p. 41.

§ Frölich, *Die Lehre von der Elektricität und dem Magnetismus*, p. 237.

‖ Frölich, *Berl. Berichte*, Nov. 18th, 1880, p. 973; also *Elektrotechnische Zeitschrift*, 1881, April, p. 139.

¶ Robinson, Trans. Roy. Irish Academy, vol, xxii., p. 1, 1855.

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formulæ have been used by Oberbeck*, Fromme†, Clausius‡, Ayrton and Perry§, and Rücker‖.

Now it must be obvious that since almost the whole of electric technology deals with the electro-magnet and its applications, it is of utmost importance to know what the true law of the electro-magnet is. If the technologist is left to the mercy of the physicist, he has to choose between formulæ that are based on physical conceptions and which are utterly unmanageable for his purpose, and formulæ that are purely empirical expressions and have no rational basis.

But the study of the modern dynamo-electric machine has brought us to a point that makes some decision a necessity. The entire action of the dynamo is dependent on the magnetising action of the electric current, and the law of the dynamo is, in the very nature of things, not to be discovered, save by the discovery of the law of the electro-magnet. It is indeed extraordinary that such able physicists as Mascart and Angot, Mayer and Auerbach, Schwendler, and Herwig sought in vain for the true law to connect the electromotive force of the dynamo with its speed, the resistance of its circuit, and the constants of its construction. Hopkinson came nearest to the mark when in 1879 he described the properties of the dynamo in terms of those of a certain curve, which we now call the characteristic curve of the machine; but he did not state the law of the dynamo algebraically, and apparently he accepted as true Weber's formula for the electro-magnet.

But the law of the dynamo is now known, and expressions have been deduced which are found to agree with the utmost accuracy with the observed facts. The discovery is almost entirely due to Dr. Frölich¶, whose papers, published at intervals from 1880 to 1885, are in their way already classical. The results first obtained by Frölich related exclusively to that form of dynamo in which the armature coils and the field-magnet coils are both included in the main circuit—the series dynamo— though they have been further extended by the present writer, and by others, including Frölich himself, to other forms of machine. A very brief résumé of Frölich's research will explain his method of arriving at the law.

His theory is based upon (1) Faraday's law of induction, (2) Ohm's law, (3) a curve, called by him the current-curve, expressing certain results of experiments made on the series-wound dynamo.

Following Faraday's principle, the induced electromotive force, E, will be proportional to the speed of the machine, n, and to a quantity, M, which Frölich calls the "effective magnetism," and which is itself proportional to the effective area of the armature coils and to the intensity of the magnetic field. Writing this as an equation, we have

$$E = n\,M,$$

and, by Ohm's law,

$$E = i\,R,$$

which gives us for the current, i.

$$i = \frac{n}{R}\,M,$$

or

$$\frac{i}{M} = \frac{n}{R}.$$

Since M is itself a function of i, and not primarily of n or R, it is clear that i is itself a function of n/R, and we may write

$$\phi\,(i) = \frac{n}{R}.$$

* Oberbeck, *Pogg. Ann.* cxxxv., pp. 74-98, 1868.
† Fromme, *Pogg. Ann.* clv., p. 305, 1878.
‡ Clausius, *Wied. Ann.* xx., p. 367, 1883.
§ Ayrton and Perry, Journ. Soc. Tele. Eng. and Elec., xii., p. 317, 1883.
‖ Rücker, Phil. Mag. ser. 5, xix., p. 463 (June, 1885).
¶ Frölich's chief papers are as follows:—*Berl. Berichte.* 1880, p. 978; *Elektrotechnische Zeitschrift*, vol. ii., p. 134 (1881); *ib.* vol. iii., pp. 69 and 113 (1882); *ib.* vol. iv., pp. 60, 67 and 71 (1883); *ib.* vol. vi., pp. 128, 139, 227 (1885).

This function Frölich set himself to investigate by pure experiment without making any hypothesis whatever. He determined the values of i at various speeds and with various resistances, and plotted out the results as a curve, values of i being taken as ordinates and values of n/R as abscissæ. This curve (see figure) he termed the "current-curve." It shows itself to be very nearly a straight line, which, however, does not pass through the origin. The portion which departs from the line is difficult of observation because it is only obtained when either n is very small or R very large, that is to say when the dynamo is scarcely able to excite its magnets. Neglecting this unstable state, and dealing only with that part of the curve which relates to the machine as it is when in action, it is clear that the relation between the two variables may be expressed as

$$b\,i = \frac{n}{R} - a,$$

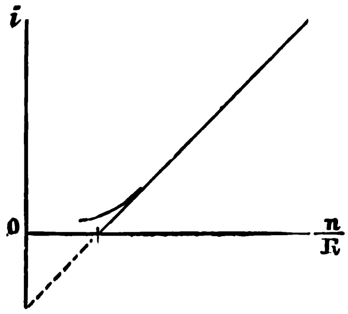
where b and a are constants; giving us as the equation of the series-dynamo:—

$$i = \frac{1}{b}\left(\frac{n}{R} - a\right).$$

Substituting for n/R its equivalent i/M, Frölich then obtained from the law of the dynamo the following expression for the "effective magnetism":—

$$M = \frac{i}{a + b\,i},$$

an expression which he himself appears, in his original paper, to have considered as a mere interpolation-formula. It is, however, this expression which is generally referred to as Frölich's formula for the electro-magnet.



It was in 1883 that the author of this paper, in working at the problem of the dynamo, realised the significance of this result of Frölich's. He had been using as the fundamental law

$$E = 4\,n\,A\,H$$

to express the average value of the electromotive force developed by rotating in a uniform magnetic field of intensity H, an armature whose total effective area was A; and requiring a formula to connect H with the exciting current, he was considering the various equations of Müller, Weber, and others, when he became aware that Frölich's expression furnished what was needed; and, finding it necessary for the case of compound-wound machines to express the excitation in terms of ampère-turns rather than of ampères, he rewrote the formula in the following way:—

$$H = G\,S\,i\,\frac{k}{1 + \sigma\,S\,i},$$

where, as before, S i is the number of ampère-turns, G a geometrical coefficient, k the coefficient of magnetic permeability in the initial stage, and σ a small saturation-coefficient dependent on the quantity and form as well as on the quality of the iron of the core.

Writing similarly Z i, for the ampere-turns of a shunt winding, the expressions for H became

$$H = G\,Z\,i\,\frac{k}{1 + \sigma\,Z\,i}$$

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for shunt-wound machines, and

$$H = G\,(S\,i \pm Z\,i_s)\,\frac{k}{1 + \sigma\,(S\,i \pm Z\,i_s)}$$

for compound-wound machines.

Inserting these values in the fundamental equation at once gave the following expressions :—

Series dynamo.

$$E = \frac{1}{\sigma}\left\{4\,n\,A\,G\,k - \frac{\Sigma R}{S}\right\}$$

$$i = \frac{1}{\sigma}\left\{\frac{4\,n\,A\,G\,k}{\Sigma R} - \frac{1}{S}\right\}$$

Shunt Dynamo.

$$E = \frac{1}{\sigma}\left\{4\,n\,A\,G\,k - \frac{r_a\,r_s + R\,r_s + R\,r_a}{Z\,R}\right\}$$

Compound Dynamo (at critical speed for regulation)

$$e = \frac{1}{\sigma}\left\{\frac{r_s\,(r + r_m)}{S\,(r_s + r_a)} - \frac{r_s}{Z}\right\}\text{(short shunt)}$$

or

$$e = \frac{1}{\sigma}\left\{\frac{r_s\,(r_a + r_m)}{S\,(r_s + r_a + r_m)} - \frac{r_s}{Z + S}\right\}\text{(long shunt),}$$

where r_a, r_m, r_s, and R are the resistances of armature, main-circuit coil, shunt-coil, and external circuit respectively, and e the difference of potentials at the terminals of the machine. These results were announced by the author at the Montreal meeting of the British Association, and were published by him in his volume on Dynamo-Electric Machinery, as was also the important proposition that the factor $\frac{1}{\sigma}$ (which may be called *the determinant* of the working power of the dynamo, since it appears in every one of the equations, both of current and electromotive force) is that number of ampère-turns which will reduce the effective permeability of the electro-magnet, or rather of the magnetic circuit, to half its initial value. It will be seen that all these synthetical results were new, except that for the current of the series dynamo, which is identical with the expression that had been deduced by Dr. Frölich from the current curve which represented his experimental results.

Since the publication of the author's treatise, Frölich has further elaborated the equations of the compound-wound machines; and a more generalised form has been deduced by Prof. Rücker in the masterly paper which he communicated to the Physical Society in March last, in which, however, he attributes to Frölich (I know not on what grounds) the general equation for the electromotive force of all kinds of dynamos. Frölich has also verified the adequacy of these formulæ by comparing results calculated from them with actual experiments on compound-wound machines. One example will suffice.

n.	R.	e obs.	e calc.	i obs.	i calc.
850	0·841	127	127	151·0	151·0
853	1·22	133	133	109·0	109·0
855	2·34	139	140	59·9	59·4
850	4·52	138	139	30·3	30·5
850	9·25	136	138	14·7	14·7
850	22·1	137	136	6·2	6·2
845	222·0	133	134	0·6	0·6

Such a series of results proves the law of the dynamo to be fully established. But if the law of the dynamo, so deduced from Frölich's empirical expression for the electro-magnet, be true, *then*, to an equal degree of precision, *must the law of the electro-magnet be itself true.*

But Frölich's expression is not the expression of any physical law : it is a mere interpolation formula, destitute of rational significance. What then is the true law of induced magnetism? And how comes it that an expression devoid of physical significance so nearly expresses the physical law?

That question the author believes to have been already solved by a forgotten investigation of Lamont, published almost without note or comment in his *Handbuch von dem Magnetismus* in 1867. On p. 41 of that work he gives the following equation,

$$m = \frac{a\,M\,x}{M + a\,x},$$

as a convenient first approximation to another equation based on a new theory of induced magnetism. In the above equation x stands for the magnetising force, m the induced magnetism, and M the maximum value of the latter. Writing G k for a, S i for x, and σ for $\frac{a}{M}$, we at once get

$$m = \frac{G\,k\,S\,i}{1 + \sigma\,S\,i},$$

which is the author's way of writing Frolich's equation.

The physical theory which led Lamont up to this result is of great interest, the more so since it has been revived during the current year in a more elaborate form by Bosanquet*, who has apparently been led thereto by an independent line of thought, and who has gone much further than Lamont in bringing in the additional consideration of the forces resisting the orientation of the molecules. Lamont's theory is, briefly, that the permeability of the iron diminishes as the permeation increases, being at every stage of the magnetisation proportional to the deficit of saturation. He assumes that for every bar there is a certain maximum of magnetisation, to which it could only attain under the influence of an infinitely great magnetising force ; and that the permeability of the bar is at every stage of the magnetisation proportional to the difference between the actual magnetisation and the possible magnetisation. This is, in other words, as if in every bar there were room for only a certain limited number of magnetic lines of force, and that, when any lesser number have been induced in it, the susceptibility of the bar to the reception of additional lines is proportional to the room yet left for them in the bar. Lamont's theory is expressed as follows : Let the magnetism present at any stage be called m, and let the maximum magnetism be called M. Then the amount which the bar can still take up is M $-\ m$; and it is to this that the permeability $d\,m/d\,x$ is proportional. Here x may be understood, as itself proportional to the number of ampère-turns of the exciting current ; and we may write

$$\frac{d\,m}{d\,x} = k\,(M - m),$$

where k is a constant depending on the units employed, and on the initial value of the permeability of the magnetic circuit when $m = 0$. Integrating we obtain

$$M - m = A\,\epsilon^{-kx},$$

where A is a constant of integration. But when $x = 0$, $m = 0$ also ; whence A = M, giving

$$m = M\,(1 - \epsilon^{-kx}),$$

which is Lamont's formula.

Lamont also develops this expression in ascending powers of $k\,x$,

$$m = M\,k\,x\left(1 - \frac{k\,x}{1\,.\,2} + \frac{k^2\,x^2}{1\,.\,2\,.\,3} - \quad . \quad . \quad . \quad . \quad .\right),$$

and he then makes the remark that it may be approximately represented by the simpler, but empirical expression

$$m = \frac{a\,M\,x}{M + a\,x},$$

which is identical in form with the expression known as Frölich's. Now, writing k for a M,

* Bosanquet, Phil. Mag., ser. 5, xix. p. 85 (Feb. 1885.)

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$$m = \frac{M k x}{1 + k x},$$

and expanding this in ascending powers, we get

$$m = M k x (1 - k x + k^2 x^2 - \quad . \quad . \quad . \quad .).$$

Neglecting the fourth and higher terms, it will be seen that the formulæ are very nearly equal for all small values of $k x$, and are identical for the value

$$k x = \frac{3}{5},$$

or when the actual magnetism has about ·456 of the value it would have under an infinite magnetising force. For larger values of the magnetising force the values of m calculated by the empirical formula are slightly greater than those calculated by the exponential formula.

None of these formulæ render any account of a phenomenon noticed in many cases where an electro-magnet is magnetised with gradually ascending magnetic forces, namely, a concavity in the *early* part of the curve of magnetisation, the permeability apparently becoming greater after a certain degree of magnetisation has been attained. The researches of Chwolson and of Siemens seem to show that this apparent increase in the permeability (which is not observed with descending magnetic forces) is due to non-homogeneity, and to the resistance of some of the molecules to magnetisation. Bosanquet's theory may be taken in connection with the recent observations of Rowland, Warburg, Ewing, and Hopkinson on this subject, which, however, is of no great importance here since the apparent maximum of permeability is attained in most cases at a much lower degree of magnetisation than that at which the dynamo is actually worked.

The very close agreement between the observed values of current and potential of the dynamo and those calculated by the equations based upon Frölich's formula, proves that nowhere within the working range do the actual values of the magnetisation differ sensibly from those calculated by the Frölich formula. That is to say, this formula may be taken as *something more than a first approximation* to the true law of the electro-magnet for all degrees of saturation of the magnets employed in practice, and may be taken as a first approximation for all degrees of saturation beyond that usually attained.

It is eminently desirable, in the face of these facts, that the imperfect formula of Lenz and Jacobi, as well as that of Müller, should henceforth disappear from the text-books of physics, and that instead thereof the true law of the electro-magnet should be stated, either in the exponential form or in the simpler form that is found to be equally true within the range of saturation attained in practice.

THE DYNAMO AS A GENERATOR AND AS A MOTOR. SOME ANALOGIES AND CONTRASTS.*

By W. M. MORDEY.

DURING the last few years an immense amount of attention has been given to everything relating to theory and practice of dynamo machines. So thorough has been the study of the problems connected with these machines, which are of a character to appeal both to the physicist and the practical constructor or engineer, that it is now not difficult to lay down, in a fairly complete form, the laws governing their action, and the rules and principles under which they should be constructed; although three or four years ago much confusion and uncertainty existed as to what was best in dynamo construction.

But in electric motors the case is very different. While it is easy to name physicists and constructors in considerable numbers who hold clear and correct views on the subject of electric generators, it is by no means easy to find definite and correct explanations of what is right and what wrong in regard to the allied subject of electric motors.

And on no point does there appear to be greater uncertainty than on that of the analogies and the differences between the two machines. For instance, while it has been proved beyond question that in dynamos the most economical and best working conditions are obtained by employing field-magnets of great magnetic strength, and armatures which are relatively very weak magnetically, the only definite assertion within the writer's knowledge given with authority on this point, asserts exactly the contrary to be the case with motors, viz., that the fields should be relatively much lighter and weaker than the armatures.*

Again, what can be more striking than the great and known difference between dynamos and motors in respect to the very important matter of efficiency! Almost any modern generator will give a return in the form of electric energy of 90 per cent. of the mechanical energy expended in it, and a useful yield of over 80 per cent. in its external circuit. In the case of the best generators this is a considerable understatement of the working conditions. With electric motors, on the other hand, one has to be contented with a much lower efficiency. The energy supplied to them is severely taxed in the process of conversion. Motors frequently yield, as mechanical energy in a useful and available form, only 30 per cent., and seldom more than 60 per cent. of the electric energy absorbed.

The reversibility of the dynamo, or its ability to work either as generator or motor, has been spoken of as one of the most important discoveries of late years (the great physicist credited with the expression of this opinion having apparently overlooked the fact that Pacinotti made his famous machine as a *motor* in the first place). But the fact that a given machine which will work well and efficiently as a dynamo, will not work so economically when its action is reversed and it is made to act as a motor, is a proof that the reversal is accompanied by some radical change in its action. This difference, where it is noticed at all, is generally sought to be explained by an assertion or a supposition that having been designed and made for one purpose, it was therefore not suitable for the other. No satisfactory explanation, as far as the writer is aware, has been given of the cause of this lower efficiency of motors, or, in other words, of how the missing power is expended. In what particulars a good motor should resemble a good dynamo, and in what they should differ from one another, are also interesting questions of great importance which await answers.

The writer having, with Mr. C. Watson—who is his assistant in the works of the Anglo-American Brush Electric Light Corporation—given some attention to the matter from a practical point of view, a great necessity was felt for some foundation on which to work, similar in character to the broad general principles which serve to guide the practical constructor of dynamo machines. In the search for such general principles, all those ways of considering the actions which depend on the idea of magnetic poles in the armature were abandoned, and the conclusion was arrived at that the armature should have no polar action whatever, that the iron of the armature should have only the function of a conductor of lines of force, and that the power of the motor should be due to the simple action between the lines of force of the magnetic field and the armature wires conveying currents at right angles to those lines of force. This mode of regarding motor action is convenient on several grounds, and leads to certain conclusions, which, if correct, form substantial bases for practical construction. Thus the armature, instead of being, as hitherto,

* From the Journal of the Physical Society.

* Profs. Ayrton and Perry, "Electro-motors and their Government," Journal Soc. Teleg. Eng. and Electricians, March, 1883.

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considered as a strong electro-magnet placed in the field of another electro-magnet, is to have its electro-magnetic functions reduced as much as possible, or preferably suppressed altogether.

The field is to be very strong.

As with such an arrangement there is no polar effect in the armature except that due to the direct magnetic induction of the field-magnets, it follows that the maximum power is obtained with any given current when the brushes occupy an absolutely neutral position, or, in other words, when there is no "lead" and no distortion or rotation of the field. These conditions do away with the most troublesome and prolific cause of the sparking at the brushes, which is so often an objectionable feature of most electric motors.

But by working backwards in this way it was seen at once that the conditions which seemed to be best for a motor were precisely those which the would-be designer of a perfect dynamo would set before him as his goal.

Certain perfect analogies had been arrived at. In both dynamos and motors, according to this briefly sketched view :—

(1.) The field should be a very strong, the armature a very weak electro-magnet.

(2.) In both generators and motors "lead," distortion, or displacement of brushes or of magnetic field is wrong, and is to be avoided by attention to (1).

Whatever "lead" there may be in either case, there is this difference, that in dynamos this "lead" is in the direction of rotation ; in motors it is in the opposite direction, as the course of the current through the armature is reversed, but the field is the same.

(3.) In both generators and motors absence of sparking at the brushes depends mainly on the conditions of (1) being complied with.

(4.) Reversal of rotation. In neither generators nor motors is movement of the brushes necessary.

But having got so far, a little consideration suggested the probable existence of another analogy. Since a dynamo, having the above theoretically perfect form and action, with a constant field, would produce a constant electromotive force if run at a constant speed, independently of the load or amount of current generated, a motor constructed on the same principles and having a constant field, if supplied with energy at a constant difference of potential, should run at a constant speed, independently of load.

If this should prove to be a true analogy, a simple means of obtaining results of great use in the practical application of electricity would be obtained—results which have been sought in many directions, more or less complicated, without any great success.

By permission of the Anglo-American Brush Electric Light Corporation experiments were carried out in the testing room of their works, with a "Victoria" dynamo. The results ultimately obtained, which are given in the following tabulated account of the experiments, and in the curves plotted for them, show that this fifth analogy is as true as the preceding ones, a constancy of speed being obtained which was very remarkable—even when the load was increased, until much more than that which, as a generator, was usually considered the full working current was traversing the armature.

Two sets of readings were taken, working up to about the same current in each set, but with the potential-difference of the supply different in the two cases, as stated. The field was of the same strength throughout. The load consisted of another "Victoria" dynamo driven through a modified White's transmission-dynamometer, the work being varied as required by altering the external circuit of this dynamo.

At first it appeared that the counter electromotive force of the motor was dependent neither on speed nor strength of field, as the latter was constant and the former very nearly so, while the current rose with the work ; but calculation showed that this was not the case, indeed, it could not be so.

Let us call the counter electromotive force e, and the loss of potential caused by the resistance of the armature e_1, and the difference of potential at the terminals E. Then

$$e + e_1 = \text{E}.$$

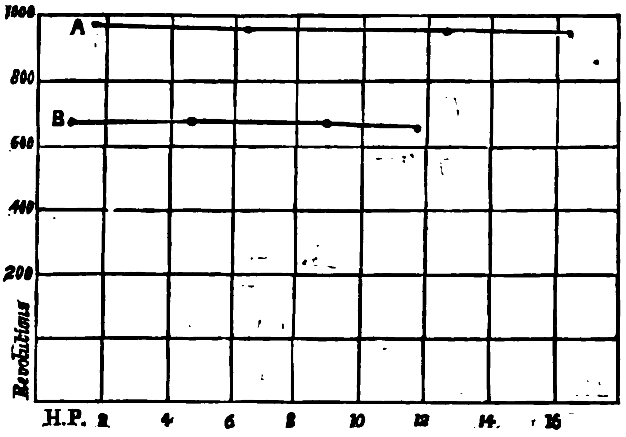
Calling the current C, and the resistance of the armature R, we know that

$$e_1 = \text{C R};$$

The resistance of the armature of the motor in question was ·027 ohm, which we will call ·03 in order to make some allowance for the effect of heating.

Experiments with a D_2 "Victoria" Shunt Motor at Constant E.M.F.

Speed.	Current.	Difference of potential at terminals.	H.P.*	
975	36·3	140	1·8	Curve A. Maximum speed-variation 3 per cent.
965	66·5	"	6·6	
948	97·1	"	12·87	
945	130·8	"	16·3	
680	29	100	1	Curve B. Maximum speed-variation 3 per cent.
677	61·4	"	4·8	
675	102	"	9.14	
660	125	"	11·7	



Curves connecting *Speed* and *Work* of D_2 "Victoria" Shunt Motor. With supply at constant difference of potential.

In the first and last readings of the second set of tests (curve B) we have therefore the following conditions :—

Speed.	e_1.	e.
680	·87	99·13
660	3·75	96·25

Now

$$\frac{680 \times 96{\cdot}25}{660} = 92{\cdot}13.$$

From which it appears that the counter electromotive force was exactly proportional to the speed, as is to be expected where the field is constant and the magnetic distortion *nil.*

The other cases do not work out with the same accuracy. The results are, however, quite within the limits of error inseparable from the rather rough conditions of these workshop tests.

One other fact may be pointed out in connection with these tables of results and curves. In the case of dynamos working with a constant field, the output with the same current is almost exactly proportional to speed, as the E.M.F. is also simply proportional to speed So with the motor, the speed is proportional to the E.M.F. of supply ; and the work, with the same current in the two cases, is simply proportional to speed, therefore to E.M.F.

With regard to the theory alluded to above, that in a motor the fields should be much weaker and lighter

* Including an unascertained loss in transmission.

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than the armature, it may be pointed out that in this, as in the other points mentioned, there is a real analogy between motors and generators, inasmuch as, according to the views briefly expressed in this note, such a motor, although a bad one from most points of view, would have a certain advantage in that for its weight it would do a good deal of work. Similarly, dynamos may be, and have been built, which, although far from efficient and reliable, will give a large output for their weight. Their construction is, however, scarcely to be recommended on this ground, except, perhaps, under very exceptional circumstances; and they, as well as the motors constructed on the same lines, appear to be instances of a mistaken apprehension of elementary principles.

Having briefly traced the analogies between generators and motors thus far, the subject may be dismissed for the present with the remark that a further consideration of the matter serves only to reveal the fact that in almost every phase of their actions the two machines afford further opportunities of a direct comparison.

Turning now to the question of efficiency alluded to above, it is evident that there is some important cause of loss or waste of energy in electric motors which is absent in generators. This has always been a kind of *lacuna* in the explanations of the action of motors; and in order to localise the loss and to ascertain its cause, the several possible sources of waste were carefully considered. These are:—(*a*) Friction at the bearings, air-friction, and friction of the brushes against the commutator. (*b*) Loss of energy in heating the armature and field-conductors, and a certain loss due to self-induction. (*c*) Loss by the production of eddy currents in the iron.

Now it is evident, especially with a generator or motor having the qualities sketched above, that at the same speed, and working with the same currents in its conductors, the losses under (*a*) and (*b*) must be identical, whether it be working as a generator or as a motor. And as with such conditions its efficiency as a motor is lower than as a generator, the cause of the loss must be sought under (*c*), *i.e.*, the eddy currents in a dynamo must be less than in a motor, all other conditions being the same. And such is the case, the explanation arrived at by the writer and Mr. Watson being a very simple one.

In a dynamo the rotation of the armature causes eddy currents to be generated in the iron core, in the same direction as in the conductor proper with which the core is surrounded. Of course, as the armature is always more or less subdivided or laminated in a direction at right angles to the lines of force, any circulation of currents round the core is avoided; but local currents, which are aptly called eddies, are set up, and, taken as a whole, these eddy currents on the outside of the core are in the same direction as the current flowing in the copper conductors.

In an electric motor, however, the eddy currents and the currents in the copper conductor are in opposite directions; as, although the E.M.F. set up in the conductor is in the same direction in a motor as in a dynamo, the current in the former is forced through the armature in a direction contrary to the E.M.F., or opposite to its course in a generator. According to the laws of induction, therefore, it will be seen that while in a dynamo the two sets of currents, those in the iron and those in the conductor, tend to oppose and to reduce one another, in a motor they act in such a manner as to mutually assist each other. Thus, with the strength of field, the current in the conductor, and the speed the same in the two cases, it will be seen that in a motor the eddy currents in the iron core of the armatures will be greater than in a generator, and therefore the heat loss in the former will be more than in the latter. There is little doubt that this is the cause of the lower efficiency of motors than of generators; and it points to the advisability of giving even greater attention in the former to those principles which are well understood for the reduction or elimination of eddy currents.

THE APPLICATION OF SPRINGS TO POLARISED TELEGRAPH INSTRUMENTS.

By K. GULSTAD.

(Communicated through Mr. H. G. Erichsen.)

It is a well known fact that the armature in a polarised telegraph instrument invariably shows a tendency to turn towards one of its two stops, or contact points, even when no current passes through the coils of the electro-magnets, and that a certain, sometimes rather considerable, force is required, in order to move the armature back.* When, however, this removal is effected beyond a certain limit, the inclination becomes reversed, and the armature now turns sharply towards the other contact point, to which it clings. The cause of this phenomenon may not be generally understood, although it is extremely simple and easily explained. It is principally due to the mutual attraction between the magnetism of the armature and that induced by it in the poles of the electro-magnets.† It must be clearly understood that any effect caused by friction, &c., is supposed to be too insignificant to be of any consequence, and that the whole polarised system here, as well as in the following, has a symmetrical plane through the axis of the armature.

In passing a weak current (just able to move the armature) through the coils of the electro-magnets, and then moving these, or their poles, closer to each other, it will be observed that this same current becomes unable to produce the desired movement of the armature after the approach of the electro-magnet poles has taken place; on the contrary, it will be found that a weaker current will suffice to bring about the result, as soon as the electro-magnets are removed from each other within reasonable limits. This experience is absolutely contrary to what might be expected from the law of the force of magnetic attraction, $f = \frac{m\,p}{d^2}$, where m, p and d respectively signify the magnetism of the armature, the magnetism produced by the current, and half the distance between the poles of the electro-magnets. According to this law the effect of the current on the armature should increase in a greatly augmented proportion as the distance between the electro-magnets became diminished. This discrepancy, as stated above, is explained by the fact that the "pressure," or "pull," of the armature at the contact points increases in a greater proportion than does the effect of the current whenever the electro-magnets are made to approach each other.

The correctness of the above explanation is proved by the calculations given below, which are based upon the above-named law and upon the expression, $f^1 = \frac{c''\,m^2}{d^4}$,‡ *i.e.*, the law of the mutual attraction between the pole of a magnet and soft iron. c'' is a constant.

In fig. 1 E and E[1] are the poles of the electro-magnets;

a, b = the position of the armature in the distance;

x = the distance of the armature from its middle position;

a, σ and d = half the distance between the poles of the electro-magnets.

The following expression gives the formula for the *natural* attraction of the armature towards E:

$$(1) \qquad A = c''\,m^2 \left(\frac{1}{(d-x)^4} \div \frac{1}{(d+x)^4}\right),$$

which can be written:

$$A = \frac{c''\,m^2}{d^4}\left(8\,\frac{x}{d} + 40\,\frac{x^3}{d^3} + 112\,\frac{x^5}{d^5}\;\ldots\ldots\right)$$

* ELECTRICAL REVIEW of 22nd August, 1885. "The Pull of the Tongue of a Telegraph Relay."

† In a Siemens polarised relay there is also an effect, caused by the permanent magnetism in the core of the electro-magnets. This, however, will not influence the result as stated in the following.

‡ ELECTRICAL REVIEW of 12th December, 1885, page 507.

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showing, that when x is rather small in comparison with d $\left(x \overline{\overline{<}} \frac{d}{3}\right)$, then :

$$(2) \qquad A = \frac{8\,c''\,m^2}{d^5}\,x.$$

The expression for the effect of the magnetism due to the current, which tends to move the armature from E towards E^1, is :

$$(3) \qquad B = \frac{m\,p}{2}\left(\frac{1}{(d-x)^2} + \frac{1}{(d+x)^2}\right)$$

$$= \frac{m\,p}{2\,d^2}\left(2 + 6\,\frac{x^2}{d^2} + 10\,\frac{x^4}{d^4}\,\ldots\ldots\right),$$

or approximately :

$$(4) \qquad B = \frac{m\,p}{d^2}.$$

It is evident that the movement of the armature can take place only when $B > A$, or when

$$(5) \qquad p > \frac{8\,c''\,m}{d^3}\,x.$$

It thus appears that the "pressure" at the contact points, besides being a resistance to the easy movement of the armature, also acts as a considerable hindrance to utilising the full effect of the current, as neither an increase of the magnetism of the armature, m, nor a diminution of the distance, d, of the electro-magnets will, generally speaking, prove to be of any avail. In some cases it has even been found advantageous to diminish and increase the constants, m and d, respectively, but decidedly with loss as regards the efficiency of the current.

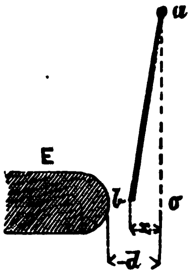

FIG. 1.

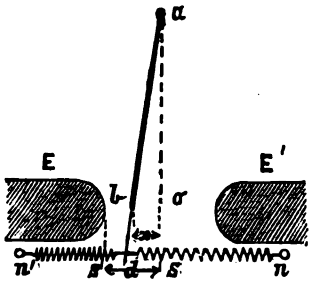

FIG. 2.

It will further be seen that, by applying the law of magnetic attraction to two magnet poles, an error is committed by having regard to the magnetic forces themselves only; this can in reality only be done where the magnetised bodies in question are saturated with magnetism, while in other cases the magnets must be considered as only partly saturated with magnetism and partly consisting of unmagnetised iron, subject to the ordinary laws of magnetic induction. This consideration should, no doubt, also be duly regarded in other cases than that treated of herein.

I may mention here that the above-named formula cannot be regarded as otherwise than approximate, owing to the equations $f = \frac{m\,p}{d^2}$ and $f^1\,\frac{c''\,m^2}{d^4}$ being by no means exact. In principle, however, the results will be the same, even if d^2 or d^4 were replaced by d^n where $4 > n > 1$, as this would only cause an alteration in the power of d in the equations (2), (4) and (5).

From the above it becomes evident that great advantages would be obtained if it were possible to neutralise the effect of the mutual and natural attraction between the armature and the poles of the electro-magnets—advantages which would appear not only in an increase of sensibility of the polarised instrument in question, but more especially in an increase of its working capacity ; as already pointed out, it is only when the "pressure" at the contact points is neutralised that the constants, m and d $\left(\text{in the formula } f = \frac{m\,p}{d^2}\right)$, can be chosen so that the greatest possible efficiency of the current can be obtained.

It is this neutralisation which I have succeeded in producing, by simply attaching springs to the armature, these springs possessing such properties, and being fixed in such a manner, that, whatever the position of the armature may be, they act upon the same with forces equal, but opposite, to those arising from the above-mentioned natural attraction. The springs must have certain capacities, as shown in the following example.

In fig. 2, $b\,n$ and $b\,n^1$ represent two springs acting in the same straight line and perpendicular on the plane of symmetry through the turning axis, a ; their two ends are supposed to be fixed to movable points, n^1 and n, and they may be stretched with certain forces which, when the armature is in its central position, a, σ, between the poles, E and E^1, effect a prolongation of δ and δ^1 respectively in the lengths marked l and l^1 of these springs. The tensions of the springs follow Hooke's law ; thus $K = c\,\frac{\delta}{l}$, and $K^1 = c^1\,\frac{\delta^1}{l^1}$, where K and K^1 are the respective spring tensions, and c, c^1, two respective constants, dependent upon the material and diameter of the springs.

Suppose the armature be placed at a distance, x, from its central position, it will then be acted upon by the springs in the direction $\sigma\,n$—opposite to that of the mutual attraction—with a force :

$$(6) \quad R = c\,\frac{\delta + x}{l} \div \frac{\delta^1 - x}{l^1} = x\left(\frac{c}{l} + \frac{c^1}{l^1}\right) + c\,\frac{\delta}{l} \div c^1\,\frac{\delta^1}{l^1}$$

As the springs, however, are supposed to be stretched in such proportions to each other that they keep the armature in its central position (no other forces acting upon it while thus placed), K must be equal to K^1. It follows, therefore, that

$$(7) \qquad R = x\left(\frac{c}{l} + \frac{c^1}{l^1}\right),$$

i.e., R is independent of the spring tensions δ and δ^1 but dependent upon the lengths and constants.

By now arranging that the factor of x in (7) becomes equal to that of x in (2)—for instance : by altering the lengths l or l^1, or by minutely varying the distance of the electro-magnets—the desired neutralisation will consequently be perfectly attained, whatever be the position of the armature. It is by applying springs in this way that I have produced a marvellous increase of the sensibility of polarised instruments, even in cases where the play is very small.

I may mention that there are polarised instruments in existence where springs are fixed as shown in fig. 2, but in the latter the magnitude $\left(\frac{c}{l} + \frac{c^1}{l^1}\right)$ is chosen so that the spring tension is much greater than is necessary for effecting neutralisation, the consequence being that the armature assumes a permanently central position, such as is intended.

It will easily be seen that the way of fixing the neutralising springs, as shown in fig. 2, is by no means the only one which can be used with advantage. If, for instance, the turning axle itself be made from a wire of given length or diameter, the result arrived at will be the same.

Whether the adjustment for attaining the above-mentioned neutralisation by means of spring tensions is more or less perfect, may be seen from the ease with which the magnetic armature follows the movements of a small piece of soft iron. Suitable springs, once properly adjusted, need, as a rule, no re-adjustment, except when in course of time greater alterations in the constants of the springs or in the strength of the magnetism of the armature may occur ; and then re-adjustment is easily effected where the poles of the electro-magnets can be moved, without disturbing the symmetry in the polarised arrangement.

As regards the influence of earth currents upon the adjustments, I must refer to equation (4). From this

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it appears that the effect of a constant earth current on the armature is likewise constant (for any position of the armature), which effect, therefore, is best neutralised by a constant counteracting force. In the example in question, such a counteraction is obtained by tightening one of the springs, $n\ b$, or $n^1\ b$, as by doing so, a constant and adjustable force $\left(c\frac{\delta}{l} \div c^1\frac{\delta^1}{l^1}\right)$ is introduced (equation (6)). The same result may be obtained when either the fixed contact points or both the electro-magnets are moved bodily to either one side or the other. In the former instance (Siemens's relay), and in the latter (the new form of Wheatstone's receiver) the springs should be attached to the movable parts.

Besides neutralising the "pressure" of the contact points, the application of springs to the armature of polarised telegraph instruments has an additional advantage, viz., that of diminishing the effect of the extra currents in a purely mechanical manner. Let the effect of the current upon the armature be A, that of the extra current B, of the natural and mutual attraction ("pressure") C, and that of the spring tensions D—all these forces supposed to be acting simultaneously—then, each time the direction of the current changes, the total effect is expressed by:

$A \div B \div C$, when no neutralisation is applied;
$A \div B$ when complete neutralisation is used; and
$A \div B + (D \div C)$, where $D \div C > 0$, when the spring tension is greater than the natural attraction.

It might, therefore, probably be found more advantageous in high-speed working to apply somewhat more powerful springs than are otherwise strictly necessary as regards neutralisation.

With regard to the application of springs I may remark that, according to circumstances, I have been able to produce a sensibility ranging from four to ten times that of the original, and that not always with a specially delicate adjustment—a sensibility the influence of which will be easily understood by experts, and which, to a considerable extent, approaches that of Sir William Thomson's recorder.*

With regard to the recorder, compared with polarised telegraph instruments, I may point out here the incorrectness in attributing the superiority of the former instrument to the absence of residual magnetism; amongst other reasons: because the principal property of the recorder is not capacity for high speed work, during which the residual magnetism specially appears, but sensibility, to which latter, leaving out of consideration the manner of working, the absence of the natural attraction between the movable part and the electro-magnets or magnets, is the only essential cause.

* I have thus succeeded in deflecting the armature of a Siemens relay through 70,000 ohms by means of one Leclanché cell, this resistance being the largest at my disposal during the time of my experiments.

MAGNETISM.

By WILLOUGHBY SMITH.

(*Continued from page* 12.)

FARADAY says that a magnetised steel ring shows no external sign of power, because the lines of force of one part are continued on by every other part of the ring; and he instanced this assumed condition with a view of strengthening *his* hypothesis. But, if such a state of things did really exist, then, in my opinion, the hypotheses I have ventured to bring forward could not be maintained; for, as I understand it, no atom or combination of atoms in any form, animate or inanimate, liquid, solid, or gaseous, can exist in an unpolarised state or without possessing magnetic lines of force. It must, of course, be understood that the external lines of force would be much stronger from a piece of metal in the form of a bar or horseshoe than they would be if the same were made into a continuous ring, assuming each to be polarised to the same intensity. As already intimated, I assume that each atom composing our atmosphere is in a state of polarisation and is influenced by the magnetic force emanating from the earth. The magnetic lines of force given out by each polarised atom of air in turn affect, more or less, each atom of matter immersed in it; and these atoms in a similar way throw out their own lines of force, and the intensity of these curved lines is no doubt influenced by the nature and form of the matefrom which the lines emanate. I know of no means by which the accuracy of all such views as these can be experimentally proved unless it be admitted, which I believe to be the case, that the force which is called gravity is the effect of such an universal system of polarisation with which God has endowed all matter.

Iron, especially when in a soft state, is very susceptible of polarisation from the effects of what is called terrestrial magnetism (the polarised atoms of the air); in fact, it is as difficult to keep it from being affected by polarisation as it would be to manipulate a sponge in a liquid without its becoming more or less saturated with it.

In my endeavour to experimentally demonstrate the existence of magnetic lines of force, I have generally employed the following very simple but efficient arrangement, which measures the intensity and shows

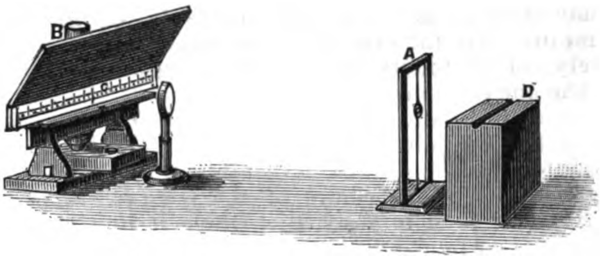

DIAGRAM 1.

the direction of the lines of magnetic force emanating from "magnetic metals," in a closed ring or in any other form, artificially magnetised, or "unmagnetised," as it is said to be, when it has not been directly influenced by a natural or artificial magnet. This arrangement is shown in diagram 1, in which A represents a short thin steel magnet suspended top and bottom by a single silk fibre in the centre of a small vulcanite or wooden frame. On one side of the magnet is fixed a small thin circular lensed mirror; the magnet, mirror, and method of suspension being similar to that generally adopted in Sir William Thomson's mirror reflecting marine galvanometers, the magnet, mirror and fibre weighing in all about 2 grains; B represents a lamp, or any convenient source of light, so placed that a beam from it will impinge on to the mirror, which reflects it on to a graduated scale, C, placed at the proper distance to receive it in the form of a well defined vertical beam about ·1 of an inch in width and 1·0 in height. The mirror, lamp, and scale should be adjusted so that, when the magnet is parallel with the lines of the earth's magnetic force, the reflected beam stands at zero on the scale. In an arrangement of this kind the resistance to its motion presented by the air, and the torsion of the fibre is so slight that the angle of deflection of the magnet is, as far as could be ascertained, directly proportional to the force affecting the same to any degree within the limits of the scale, and from such delicacy great accuracy is insured. D represents a stand, placed at the back of the magnet, on which the body under experiment is manipulated. This stand should be in no way connected to that on which the magnet is placed, in order that all disturbances from mechanical movements and other causes may be prevented from affecting the magnet. The number of interesting and instructive experiments which can be made by the aid of this simple arrange-

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ment will not be apparent at first sight, but, as the experimenter proceeds, he will find that as soon as he has settled one question to his own satisfaction, another will suggest itself.

A rod of annealed charcoal iron 10 inches in length and ·31 inches in diameter, the length being divided by marks into 20 equal parts, was placed in a groove on stand D, and at a distance of 6 inches from the magnet. The positions of both magnet and rod were north and south, consequently they were parallel to each other. The north end of the rod was first placed exactly opposite the centre of the magnet, and the deflection of the magnet noted, the rod of charcoal iron being polarised by the earth's magnetism alone, or, to speak more correctly, by the polarised molecules of air in contact with it; the rod was then slowly moved in the same straight line towards the north, and the deflection noted every time one of the marks on the bar was opposite to the centre of the magnetic needle.

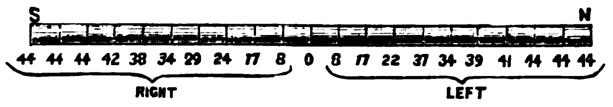

DIAGRAM 2.

The results are shown in diagram 2, where it will be seen that at or near the end pointing to the north the deflection produced is at a maximum to the left of the scale, and that, as the rod is moved, the deflection gradually decreases until the centre of the rod is at right angles to the centre of the magnet, when all influence of the rod upon the magnet apparently ceases; but, as the movement of the rod proceeds, the magnet becomes again affected, but in the opposite direction, the deflection being to the right of the scale; and it gradually increases until the south end of the rod is at right angles to the centre of the magnet, when the maximum is again reached. Other results observed with this particular specimen of iron showed that the amount of magnetism and direction of polarity induced, depended upon the position in which the rod was held. And, consequently, if the position were changed, the intensity and polarity were also changed.

If the iron rod be placed parallel with the earth's magnetic lines of force, it will become magnetised in the direction of its length, but if placed at right angles to these lines it becomes magnetised in the direction of its width; or, in other words, a magnetisable body becomes magnetised by induction from the polarised lines of the earth's magnetism, in a direction parallel to those lines. The value for any particular position remains constant, so that, whenever the rod is placed in the same position, the same value is obtained, provided the rod has not been subjected to any mechanical agitation. It therefore follows that the magnetism induced in the rod may be varied or reversed, by simply altering its position in relation to the earth's magnetic polarised lines. A few moments' thought and reasoning on the nature and results of this experiment may not be altogether without instruction.

Consider that a length of magnetised iron or steel of any form, will, if at liberty to do so, always rest in a position symmetrical to the polarised lines of magnetic force emanating from the earth or from any other source. If, however, there are two sources of magnetic polarisation acting at the same time, then the iron or steel will take up a mean position. The iron and steel emit their own polarised lines of force, which, more or less, affect each other, endeavouring so to move the masses of metal from which they proceed as to permit of the lines of force emanating therefrom being, as nearly as possible, symmetrical to each other, and then all apparent influence ceases. In the case of the small magnet, freely suspended in the neighbourhood of the polarised rod of charcoal iron in the experiment before described, the rod of iron and the small magnet both sent forth their own lines of polarisation, causing the relative position of the two bodies to be so altered as to allow the magnetic lines of force emanating therefrom being symmetrical to each other, or, at least, as nearly so as the interfering earth's magnetic field permitted them to be. In this case it is only the magnet that moves, the rod being, for all practical purposes, a fixture. It follows that what is taking place when the iron rod is moved in the vicinity of the magnet in the manner before described is, that, as the rod is moved the lines of force proceeding therefrom are also moved; consequently, the position of the lines relatively to those produced by the magnet is changed, and the latter, being free to move, is influenced by its own lines of force, which change their position until they again become symmetrical to those of the rod, and thus the deflection of the magnet is caused. It has long been known that a magnetic needle, if suspended so as to be movable only in the vertical plane, will remain in a *horizontal* position at the magnetic equator; but, if gradually moved from that position either in a north or south direction, it will assume every degree of inclination until it reaches the magnetic pole, and there it will take up a *vertical* position. This is called the magnetic dip, and, as far as I know, no satisfactory explanation has been given to account for the phenomenon, but I consider it a beautiful illustration of the correctness of the hypothesis which I have above ventured to put forth.

In diagram 3 I have endeavoured to better illustrate these lines of force and their effect on each other, as my imagination represents them. A, B and C, show the positions assumed by the magnet in relation to the influence of the lines given out by the iron rod. As I imagine it, each atom contained in the rod of iron has its own polarising effect, consequently, each atom forming the surface of the rod affects the atoms of the medium surrounding it, and, that being so, how inadequate must be the representation of those lines, which in reality must be more numerous than the most sensitive human imagination can conceive; in fact, the phrase "lines of force" is a mere figure of speech, used for the purpose of clearly indicating the direction of polarisation.

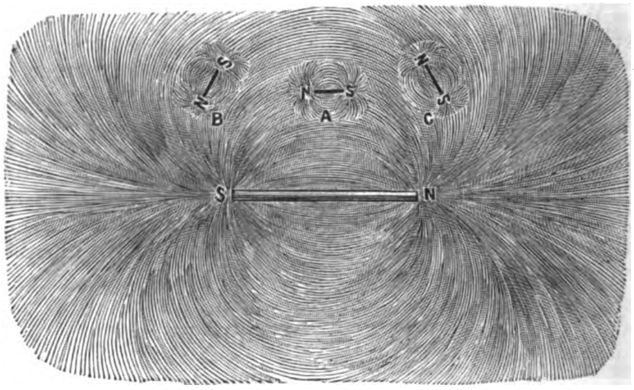

DIAGRAM 3.

Dr. Gilbert, to whom I have already referred, was the first to discover, or at any rate to publish the interesting fact, that the intensity of a magnet is altered when the iron or steel is affected by any mechanical percussion. To illustrate this, let the iron rod, as used in the last experiment, be in such a relative position to the magnet as to cause a certain deflection, it being understood that the rod is magnetised simply by reason of its position in the earth's magnetic field; and, while in that position, north and south, let one end of the rod receive a blow from any mechanical contrivance; the deflection will be then increased, and will continue to increase after each blow up to a certain point, after which no mechanical influence appears to affect its magnetism. In an actual experiment the maximum deflection was reached at the fifth blow, and the ratio between the maximum and minimum deflection was as 1 to 2·34: for instance, with the rod in a horizontal position, north and south, the deflection was 23·5, and after the fifth blow it was 55·, or 2·34 times the amount.

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On another occasion when the rod was in a vertical position the deflection was 64 divisions, and after the fifth blow 150 divisions, which is, as in the previous case, 2·34 times the original amount; the ratio of increase varies, however, with each specimen of iron, and depends upon its purity and dimensions.

The magnetism is not only increased by mechanical percussion, but the increase is to a great extent permament whilst the rod remains undisturbed; but if its position be changed and it is again subjected to mechanical percussion, the previous magnetism will disappear and a fresh maximum value will be obtained, which is the maximum value of the new position. Mechanical percussion appears to affect more or less magnetism, developed in any known form; but to arrive at definite and positive conclusions, a series of long and well devised experiments must be conducted with extraordinary care and patience, as there exist such a variety of circumstances, each one of which, if neglected or overlooked, might vitiate the correctness of the results. The following experiment was made in electro-magnetism. A bar of round charcoal iron ·25 inches in diameter, and 12 inches in length, was annealed by being raised to a red heat, and then allowed to remain undisturbed until the fire had died out and the bar become cold. Over a brass tube, ·31 inches internal diameter and 10·5 inches in length, were wound 520 turns of silk-covered copper wire, the total resistance of which was ·72 ohm. This helix was joined in circuit with a battery, a resistance and a key, as shown in diagram 4; H represents the helix and brass tube; I, the iron rod; R, a resistance which could be varied as required; G, one Grove cell with an electromotive force at commencement of experiment of

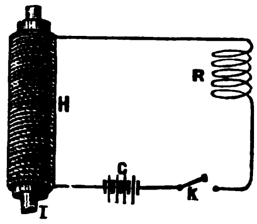

DIAGRAM 4.

1·92, volt and resistance of ·23 of an ohm; K, an arrangement for making or breaking the circuit, and M, the small mirror-reflecting magnet. The resistance, R, was at first adjusted so that the intensity of the current passing through the helix alone was only ·0019 of an ampère. The lines of force given out by the helix under these conditions, and their effect on those emanating from the magnet, M, were then noted. The circuit was then broken at K, and the iron rod inserted in the helix by placing it in the brass tube. The rod was placed at right angles to the magnetic meridian, for, in that position it was not sufficiently influenced by the earth's polarised lines of force to affect the magnet, M. The circuit was then again made, and the deflection of M was as given in column A, table I. While the current was flowing the lower end of the rod was repeatedly struck until the maximum deflection of M was obtained, which is given in column B of the same table. After each experiment the iron rod was demagnetised, and the deflection caused by the helix alone for each current deducted from the values given. The current was then increased and the experiment repeated and so on, the results being all recorded in the table. The energy of the mechanical percussion necessary to increase the value in column A, to that given in column B, increases with the intensity of the current flowing, and therefore with the intensity of the magnetism induced in the rod; and it will be seen by reference to the table, that the greatest increase due to mechanical agitation is obtained when the bar is only very feebly magnetised. If the generally accepted theory be correct, a rod of iron becomes magnetised in proportion to the intensity of the magnetic field in which it is placed, unless it be near the point of saturation, and, as the magnetic intensity is proportional to the current flowing through the helix, it follows that the rod should become magnetised in proportion to the current flowing; in other words, ten times the current should produce ten times the magnetism. The values given in column B approach closely to that law, except when the rod is near saturation, but not so the values in column A. It may be assumed, I think, that the values in column B are the more correct; and that with low magnetising power, mechanical percussion is necessary for the production of the true amount of magnetism corresponding to the inducing power.

TABLE I.

Current flowing through the magnetising helix. Ampères.	Deflection of the small suspended magnet.		Ratio $\frac{B}{A}$
	A Normal.	B After mechanical agitation.	
·0019	2·5	7·5	3·0
·0024	3·0	9·0	3·0
·0032	4·0	12·0	3·0
·0038	5·0	15·0	3·0
·0048	6·5	19·5	3·0
·0064	8·4	24·0	3·0
·0076	10·5	29·0	2·76
·0095	13·5	37·0	2·74
·0127	18·5	48·0	2·60
·0190	29·5	74·5	2·52
·0237	39·5	90·0	2·30
·0315	57·5	122·5	2·13
·0376	71·0	144·0	2·03
·0468	93·5	176·5	1·88
·0533	112·0	203·0	1·81
·0619	136·0	234·0	1·72
·0738	178·0	278·0	1·56
·0914	231·5	351·5	1·52
·120	331·0	465·0	1·40
·148	424·0	570·0	1·34
·174	521·0	664·0	1·27
·214	661·0	811·0	1·23
·276	865·0	1044·0	1·21
·388	1254·0	1458·0	1·16
·486	1625·0	1813·0	1·12
·651	2149·0	2349·0	1·09
·985	2850·0	2944·0	1·03
2·021	3391·0	3426·0	1·01

I have already pointed out that it is necessary to observe great caution in manipulation, to avoid arriving at false conclusions while endeavouring to ascertain the existence, and true direction, of the lines of magnetic force of a body while under the influence of the earth's polarised lines of magnetic force; and this precaution applies, even more forcibly, when making similar experiments with an iron ring or disc. A rod of best charcoal iron ·25 inch in diameter was welded into a ring 3·8 inch external diameter and made red hot; and, while in that state, was laid on a sheet of asbestos and slowly revolved in a horizontal plane until cool. This mode of cooling was necessary, for experience had taught that if the ring remained stationary while cooling, slight, but fixed polarity manifested itself at the parts of the ring facing north and south; but that if it were revolved, as mentioned, whilst cooling no fixed polarity was manifested; therefore, when the ring was placed horizontally so that the small magnet was in a direct line with the centre of the ring, no deflection of the magnet occurred; and although the ring was revolved while maintaining the same relative position to the magnet, still no deflection could be observed. It might be assumed, from this, that no lines of force were being given off by the ring, but a little thought on the subject will, I think, prove such an assumption to be incorrect. The polarised lines of the earth's magnetism affect the polarised atoms of the iron ring in their own direction, north and south, consequently the lines given out by the ring are symmetrical with those emanating from the small magnet, and, as I have already shown in the case of the iron rod, no apparent effect is developed, and it therefore follows that this condition would not be altered by revolving

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the ring, for, as it possesses no fixed polarity, the poles would be continually in the parts facing north and south. But if either side of the ring be brought in line with the centre of the magnet, then the positions of the polarised lines relatively to those of the magnet are altered, and, as already explained, the magnet is deflected as illustrated in diagram 5. A plate of iron, circular or of any other form, behaves in this respect

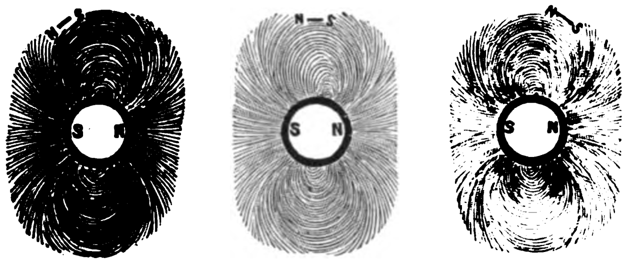

DIAGRAM 5.

precisely in the same way as the ring. The magnetic intensity in either case is increased, and definite polarity defined by a slight blow; even the flick of the finger is sufficient to produce an effect. Increase of temperature produces precisely the same results as a blow from any mechanical means. May we not therefore say that what we designate heat is the cause in each case? for it is well known that a few well-directed blows on a rod of iron will considerably increase its temperature.

(*To be continued.*)

OBITUARY.

ALFRED TRIBE.

THE late Alfred Tribe, F.R.Inst.Chem., F.C.S., whose untimely death was notified in our issue of the 5th ult., was born in London in 1839. While yet a child he exhibited a remarkable tendency for scientific investigation, especially in the fields of chemistry and electricity. His earliest professional engagements were with Dr. Forbes Watson, Dr. Medlock, and Prof. Williamson, of University College. In 1859 he became demonstrator of chemistry in St. Thomas's Hospital, which appointment he resigned in 1862, in order to prosecute his studies at Heidelberg under the celebrated Professors Bünsen and Kirchoff. Shortly after his return from Germany he undertook the management of Dr. Gladstone's research laboratory, whence, during the past twenty years, numerous scientific papers have been issued bearing their joint signatures. Among the best known of them are a series on the Copper Zinc Couple, and another on the Chemistry of the Planté and Faure accumulators. Mr. Tribe was also the author of many scientific papers which have been published in the Proc. Roy. Soc., Jour. Chem. Soc., Phil. Mag., &c., and the results of many of his famous electrical researches are embodied in Vol. II. of the late edition of Gordon's "Electricity and Magnetism," where the beautiful plates illustrating his experiments add a great attraction to the work, and in specifications of patents for his electrical storage battery. Amongst his most celebrated private researches have been those on the distribution of potential in the electrolytic field, and on the refraction of electricity; while his labours in the field of electric storage batteries have yet to be made more public to be rightly appreciated. His best known public appointments have been Lecturer on Chemistry in Dulwich College since 1874, and Lecturer on Metallurgy to the Medical School of the National Dental Hospital. His candidature for the Royal Society was supported by some of the most eminent fellows, notably, Sir W. Siemens, Profs. Spottiswoode and Tyndall; and it is more than probable that his untimely end has only just anticipated that legitimate reward of a genuine and productive devotion to the cause of science.

REVIEWS.

Dynamo-Electric Machinery. By SYLVANUS P. THOMPSON. Second Edition, Enlarged and Revised. E. and F. N. Spon, 125, Strand, London.

The publication of the second edition of "Dynamo-Electric Machinery" will be welcomed by all who are interested in electric light work. The addition of extra matter to the extent of over one hundred pages has added greatly to the value of the original work. The new information has been partly given in the form of a number of appendices, and has partly been worked into the text; thus Chapter V., on "The Reactions between the Armature and the Field Magnets" has been rewritten, introducing a section on the heating of pole pieces. Chapter XI., on "Machines for Electro-Plating and Metallurgy," is entirely new, as is also Chapter XIX. on "Coupling two or more Dynamos in One Circuit." The author points out that it is in the theory of the dynamo that the truest progress has been made. Taking the theory of Frölich as regards the electro-magnet as being the most correct for practical purposes, Prof. Thompson essayed in the first edition of his book to complete the theory of the dynamo on the foundation thus laid; a further elaboration of the expressions the author deduced has been carried out by Frölich, and a summary of these is given in Appendix IV. It is pointed out that the results agree with extraordinary accuracy with observed facts; but, as the formulæ are empirical ones, they cannot be taken in themselves as complete fundamental expressions, though the author believes he has succeeded in identifying them with formulæ originated by Prof. Lamont so long ago as 1867. A great feature in Prof. Thompson's book is the fact that it is not overloaded with a mass of formulæ which make the hair of the practical reader stand on end; the work is thoroughly practical, though theory is by no means neglected.

BOOKS RECEIVED.

Clark's Transit Tables for 1886. London: E. and F. N. Spon, 125, Strand.

The Railway Diary and Officials Directory for 1886. McCorquodale & Co., Limited, Cardington Street, Euston Square, London, N.W.

Sell's Directory of Registered Telegraphic Addresses. London: Henry Sell, 167, Fleet Street, E.C.

LAYING A NEW CABLE.

A CORRESPONDENT gives the following interesting account, in the *Sind Gazette* of December 4th, of the proceedings of the expedition to lay a new cable from Jask to Bushire, which has just completed its labours:—

The cable was coiled in the tanks of the steamships *International* and *Dacia*, 191 knots in the former and 339 in the latter. These fine vessels both belong to the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, by whom the cable was manufactured. The laying was carried out under the personal supervision of Colonel Bateman Champain, R.E., the Director-in-Chief of the Indo-European Telegraph Department, assisted by Sir Henry Mance, C.Inst.E., M.I.C.E., the electrician and engineer of the Persian Gulf Section of the same department. The ss. *International* proceeded direct from England to Jask with Mr. H. Harrison, of the Indo-European Telegraph, on board in charge of testing arrangements; whilst the ss. *Dacia*, carrying Colonel Bateman Champain and Sir Henry Mance touched at Karachi on the morning of the 10th November and continued her voyage the next evening, having picked up at Karachi Mr. B T. Ffinch, Mr. Newnham, Mr. C. E. Allen, Mr. Andrews and Mr. Hopkins.

On board the *Dacia* some excitement and alarm occurred when the vessel was off Manora by the always awful cry *man overboard*. This cry cleared the dinner table at once, and an anxious crowd

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was soon gathered round the bulwarks. Some said that there were two men in the water, but that one had seized a life-buoy, two of which, self-lighting, were promptly thrown overboard, one by the captain and the other by the quartermaster at the wheel. A boat was lowered in a miraculously short time, and the crew giving way with a will were soon up with the poor fellow who was on the buoy. A gloom was beginning to creep over us all when it was whispered that they could not find the second man. This was, however, quickly dispelled when we heard for certain that only one man had fallen into the water, and he, after a stiff glass of brandy administered immediately from the medical comforts by Dr. Scully, was soon able to give us the benefit of his experiences. The accident was caused by the breaking of the swing bolt of one of the davits when hauling the steam launch on board. Two men were on her at the time, but one leapt on board the steamer as the launch was falling. The launch sank, and it was deemed advisable, to prevent further delay, to attach a buoy to her and proceed on our journey. On reaching Gwadur we were informed that the launch had been raised and taken into harbour by the master attendant, Captain Parker.

Nothing further of interest occurred until we anchored off Gwadur at 3.30 a.m. on the 13th November, where we took off Mr. Barker, and were informed that the remaining cable between Jask and Bushire had broken near the former station. As an example of the accuracy and smoothness with which all the arrangements for this expedition had been calculated beforehand and were carried out to the letter, we found on arriving as Jask without further mishap on the morning of the 14th, that the ss. *International* from England had anchored there the previous evening, and the ss. *Patrick Stewart* from Bushire appeared in sight soon after our arrival. By noon on the 15th the broken cable had been repaired, and the shore end of the new cable laid. At 3.25 p.m. the splice with the shore end was completed, and the *International* commenced paying out; the hitherto passengers on board the *Dacia* were told off to their different duties on board the *International*, and everything proceeded with regularity and order. Sir Henry Mance was ably assisted by Mr. Theophilus Smith, the representative of the India Rubber Company; also by Captains Tindall and Barker of the *International* and *Dacia* respectively, who with their officers and crew, and in fact everyone connected with the two ships, made by their courtesy and attention to the comforts of the officers and employés of the Indo-European Telegraph Department what might have been considered arduous duty into a pleasant trip.

The three ships left Jask in the following order:—(1) the *Patrick Stewart*, our guiding star; (2) the *International* paying out cable; (3) the *Dacia* with a fresh supply of cable, and taking soundings in our track. Soon after midnight on the 17th November the *International* finished paying out her 191 miles and buoyed the end. The staff were in the morning transferred to the *Dacia*, and by 3.25 p.m. the cable on board the *Dacia* was spliced to the buoyed end and paying out recommenced, whilst the *International*, her work being done, left us for Karachi, taking in her Mr. Newnham as a passenger for Europe. We believe she goes from Karachi to Antwerp with cargo.

With the exception of a rather heavy N.W. swell on the afternoon and evening of the 18th nothing worth noting occurred, and by 9 a.m. on the 20th about 323 miles had been paid out from the *Dacia*. The cable was now cut and buoyed, and the ship anchored off the old fort of Reshire at 9.55 a.m. Colonel Ross, the Resident at Bushire, now came on board, and after a short visit returned to Bushire accompanied by Colonel Champain, to make the necessary arrangements for landing the shore end of the cable. At 2.5 p.m. the shore end passed over the bow of the ships, and at 3.8 p.m. the first balloon buoy reached the shore. This was a most interesting sight, as a mile and a-half of cable was floated ashore on 32 buoys. About 9 p.m. the final splice between the shore end and the deep sea cable passed over the side of the ship, after which, with hearty cheers for Colonel Champain, Sir Henry Mance, and the Indo-European Telegraph Department, reciprocated with others for Mr. Theophilus Smith and the officers and employés of the India Rubber Company, the laying of the new Jask-Bushire cable came to an end, and all hands proceeded to splice the main brace.

To anyone unconnected with telegraphy the various appliances by which telegraphists can communicate with each other either by night or day by using the Morse code would appear by no means the least interesting feature of the expedition. The following methods of signalling were employed during this journey, all with great success, viz., steam whistles, flags, heliograph, lanterns, and the electric current.

We Daciaites, who had been expecting cooler weather all the way from Aden, were buoyed up with hope from Sir H. Mance's knowledge and prognostications that Karachi would be cooler, and then Jask and eventually Bushire, but only to be disappointed, as each place seemed warmer than the last, and finally on reaching Bushire we were informed that if we had only arrived the previous month we should have found it quite cool.

The ship went round to the Bushire roads on the evening of the 21st, and anchored. All who were able to obtain permission went on shore, and soon every means of locomotion in Bushire, including the Resident's carriage and most of the available *mokes* in the place were in full requisition, carrying visitors and callers from place to place. Even our scientific little skipper was noticed with two companions in a remarkable one-horse trap. The gallant captain held the rudder lines, and had, I am told, to be occasionally admonished with cries of "port, port," or "hard a starboard," when passing round corners. The Bushire Residency was as full as it could possibly hold, even to overflowing, as many of the visitors had to take shelter in tents outside. To give some idea of the extent to which the hospitality of the Residency was taxed, I noticed besides the home party consisting of Colonel and Mrs. Ross, their two daughters, and Dr. Ross, Residency Surgeon, Colonel Champain, Mr. Ffinch, Sir. H. Mance, Mr. T. Smith, Captain Bishop of the *Patrick Stewart*, Mr. Possmann, and Dr. Scully, from Shiraz. Dr. Scully and Dr. Odling changed appointments, the former acting for Dr. Odling at Shiraz, whilst the latter becomes our ship's doctor for the voyage home, where he is proceeding on leave. Everyone in and about Bushire followed the example set at the Residency, the fame of which for hospitality while under the control of Colonel Ross and his kindly wife has spread further than they could possibly imagine. Luncheons and dinners to the travellers was the order of the day; large parties of eighteen and twenty met every evening for dinner at the Residency, whilst in the afternoon almost all the Europeans in and about Bushire met on the esplanade in front of it, where Mrs. Ross presided at a tea table, whilst lawn tennis went on merrily and others promenaded. The Malek Tojar, or chief of the merchants, occasionally sent his band of Portuguese to enliven the gay scene. The musicians played well, but had rather an incongruous appearance, being dressed in uniform—red coat and black unmentionables, but allowed to wear their own soft black felt from Bombay.

On the 23rd Mr. Theophilus Smith asked a large party off to luncheon on board the *Dacia*, including all those already mentioned and Mr. and Mrs. Robertson, Mr. and Mrs. G. Sealy, Mr. and Mrs. C. Williams and many others. The party after enjoying an excellent luncheon, at which Colonel Champain made a humourous speech in honour of Mr. T. Smith and the India Rubber Company, were shown over the vessel and then returned to shore delighted with their visit. On the 23rd after a parting luncheon at the Residency during which the Captain of H.M.S. Gunboat *Philomel* joined us (that vessel having arrived in port) we again proceeded on board, several of the Bushire residents accompanying us to the vessel. Here we bade a last farewell to our hospitable hosts and proceeded on our return journey.

The weather continued warm, and as we were to call in at Jask for our mails and found we had several hours to spare so as not to arrive there in the middle of the night, Mr. Smith and the Captain were prevailed upon to anchor off Kishem at 9.50 a.m. on the 26th, and a party was soon formed to visit the salt caves on that island. After a three hours' scramble during which we visited four salt caves in some of which blue, green and red lights were fired, causing most magnificent effects and scenes like those in a pantomime, we returned to the ship laden with stalactites and crystals, having thoroughly enjoyed ourselves. Colonel Champain entered fully into the fun of the thing, and although we had several sharp showers of rain ran about as well as the youngest of the party. We anchored off Jask by daylight on the 27th, received our mails, and without anyone having gone on shore proceeded on our voyage to Karachi, which we reached safe and sound on Saturday, the 29th November, about noon.

NOTES.

House Lighting in Yorkshire.—An extensive installation of domestic electric lighting has just been completed at Oakworth, Yorkshire, the seat of Mr. Isaac Holden, M.P. It comprises about 150 incandescent lamps; a dynamo of the most improved type, capable of driving 100 incandescent lights of 20 candle-power each, and specially made either for charging secondary storage batteries or running the lights direct. The dynamo is also furnished with a flywheel to compensate for the irregular motion of the gas engine. There is a secondary battery of 110 cells in two sets of 55 in a little house in the garden, which is capable of maintaining 100 lamps for ten hours at a stretch without recharging. This, under ordinary circumstances, gives a very large margin for reserve. The power for driving the dynamo is supplied by an 8 horse-power Crossley gas engine. The dynamo chamber and engine-house is connected with Oakworth House by a large cable, which is laid to the butler's pantry, from which radiate all the minor cables for the various rooms. Here there is a perfect system of switches and safety fuses, all under the immediate control and supervision of the person in charge. The switches and fuses are the invention of Sir William Thomson, and have been specially arranged for this installation. In the large reception-rooms the splendid chandeliers formerly used for gas have been retained and adapted in the most perfect manner for carrying incandescent lamps, which are arranged in groups, screened by beautiful engraved and ground glass

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globes. In each room and hall there are also independent switches, so that the whole or a portion of the lamps may be put on or off at the pleasure of the occupants of the apartments. Such lamps will as a rule be served by the accumulators. The light is absolutely steady, and the effect is brilliant in the extreme. The installation has been carried out by Messrs. Muir and Mavor, of Glasgow, who have had large experience in this work, being contractors to the Government for the lighting of the Glasgow General Post Office, in which installation there are 400 incandescent lamps and 10 arc lights, most of which are running day and night.

Domestic Electric Lighting.—We have a considerable portion of our space taken up this week with matters relating to house lighting, and doubtless this will prove specially interesting to the majority of our readers.

If Sir David Salomons would now give particulars of his extensive installation at Tunbridge Wells, we are sure that still greater attention would be turned to the subject of domestic electric lighting, for it is well known that this gentleman's experience is of an almost unique character.

Water Power and Electric Lighting.—At a meeting of the Leeds Town Council, held last Friday, a Bill promoted by the Leeds Hydraulic Power Company was considered. The Bill would give an impetus to the electric lighting system. The company would be able to supply persons with power for lighting private houses and warehouses by electricity. The company wanted exclusive powers; they desired to have the monopoly themselves, and did not wish the corporation to have power to buy them up. If the Bill were carried the company would exercise the monopoly for ever, but the Bill would not be pressed if the corporation thought it would be detrimental to Leeds. It was agreed to let the subject stand over.

Sir S. P. Grant, of Rothiemurchus, on the river Spey, has introduced 80 Swan lamps into his house, and lights them by an electric current derived from a Phœnix dynamo, which is driven by a turbine. The current first charges accumulators, from which it is drawn to feed the lamps. The water is obtained from the stream by a mill-race, and on which the turbine house is situated. The stream is three-quarters of a mile from the house.

Electric Light at Middleton. — Messrs. Mather, Ormesher & Co.'s Bridge Mill, Middleton, has been for some months lighted by electricity on the incandescent system. The lights are each of 20 candle-power, and 50 of them are fixed in different parts of the works. The lights can be switched out anywhere at will, and can be all in work at once, or any less quantity down to a single light, as may be required. Messrs. Mather, Ormesher & Co. have expressed themselves perfectly satisfied with the change, and with the manner in whtch the work has been completed. The installation was erected by Mr. Thomas McClellan, of Radcliffe.

Electric Light Work in 1885. — Messrs. R. E. Crompton & Co. inform us that during the year 1885 they have completely re-organised their manufacture of dynamo machines by the substitution of the Crompton machine for the Bürgin type in all sizes and patterns. They have been fortunate enough to keep their works fully employed, and have kept a night shift going throughout the whole of the year. During the early part of the year they finished the fitting out of the Brazilian ironclad *Aquidaban*, and made six sets of search light apparatus, including engines, dynamos, projectors, &c., for the new type of sea-going torpedo boats in H.M. Navy. They also manufactured search light apparatus for H.M. ships *Black Prince*, *Shannon*, *Scout*, *Landrail*, *Curlew*, *Caroline*, *Royalist*, *Acorn*, and three others; and manufactured for the Admiralty twenty-eight sets of search light apparatus for store. Complete installations were fitted up at Sir John Fowler's house, Braemore, on the training ship *Exmouth*, for the Birmingham Liberal Club, for the Mersey Docks and Harbour Board, for the Meisenbach Company, for the Royal Institution, for the E. & W. I. Dock Company, and others. They supplied dynamos and apparatus direct for the lighting of Buckingham Palace, for Lord Bute at Cardiff Castle, for Sir David Salomons, and many others; in addition to these, through their various agents, Messrs. Bennett and Company, J. P. Fearfield, W. Hartnell, Holmes and Vaudrey, J. C. Howell, H. Lea, Muir and Mavor, and others, they supplied nearly a hundred dynamos, as well as various other apparatus, to form part of installations in different parts of the country. They have in hand, and nearly complete, a very heavy contract for the Imperial and Continental Gas Association, consisting of dynamos, steam engines, &c., for electric lighting at Vienna. They have also in hand a large contract for the E. & W. I. Dock Company for the complete lighting by electricity of the new Tilbury Docks. Messrs. Crompton & Co. have during the year brought out some notable improvements in the construction of search light apparatus by the use of the Carver mirror in place of the Mangin projector, hitherto employed in H.M. Navy. They have also designed and are executing an order for the lighting of a lightship belonging to the Mersey Docks and Harbour Board. This is a highly satisfactory summary of a year's work, and plainly shows that the electrical industry is not yet at a standstill.

Large Electric Light Installation.—Messrs. Colville and Son, Motherwell, have entrusted the Messrs. Norman, of Glasgow, to lay down a complete system of electric light, and as a consequence gas will be dispensed with immediately. The installation is to consist of 200 incandescent lights and 32 arc lamps, which are to burn for 18 hours at a stretch. The same firm have just completed the lighting of Mr. Clark's yacht, the *Mohican*, in which accumulators are largely used.

Change of Address.—The South of England Telephone Company announces that on and after the 4th January next, its address will be 50, Old Broad Street, London, E.C.

The office of the West Coast of America Telegraph Company is removed to the same address.

The Keighley Telephone Exchange.—On the 30th ultimo the Mayor of Keighley formally opened the new telephone exchange, which has just been completed in Keighley by the National Telephone Company. There were present several directors of the company, and a number of the leading gentlemen of the town. The Mayor sent the first message to the Mayor of Bradford, congratulating him upon the opening of the communication between the two towns. Several speeches were made, and messages were also exchanged with other towns in the West Riding, with which Keighley is now in telephonic communication.

The Telephone to Replace the Telegraph.—At a meeting of the Edinburgh Town Council approval was given to a recommendation of the Plans and Works Committee that telephone be substituted for telegraph communication between the head police offices in Edinburgh and Leith.

Personal.—We regret to hear that Mr. J. Aylmer, of Paris, who is well known in English electrical circles, has met with a very serious accident. On Wednesday, the 30th ultimo, whilst fixing tho wires for some experiments he was about to carry out in his office the ladder slipped, and Mr. Aylmer came to the ground with such force as to dislocate his right shoulder, break his right thigh, and give himself several severe contusions. Mr. Aylmer's friends will be glad to hear that under skilful medical treatment and careful nursing he is making satisfactory progress towards recovery.

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Telegraph Revenue.—The receipts on the telegraph service for the quarters of the past year were :—March 31st, £405,000 : June 30th, £445,000 ; September 30th, £490,000 ; December 31st, £410,000. The receipts for the quarters of 1884 were :—March 31st, £390,000 ; June 30th, £440,000 ; September 30th, £485,000 ; December 31st, £430,000. Thus it will be seen that, although there is an increase of revenue for the year of £5,000, there is a decrease of £20,000 in the receipts for the last quarter of the year ; this, of course, is to be accounted for by the cheapening of the rates for transmission of telegrams.

The Telegraph in the Soudan.—The resumption of hostilities in the Soudan again renders the maintenance of telegraphic communication important. On the 31st ult. the line was interrupted at Korosko, but, after communication between Cairo and the front had been broken off for only a day or so, it was restored.

Generosity among Telegraphists. — The Chicago telegraph operators very generously made up a purse for the sufferers by the Galveston fire, the funds to be presented to the ten telegraph operators at that place who were losers by the fire, several of whom have families.

Another use for the Telegraph.—In Norway it is believed that wolves are frightened away by telegraph lines. While a vote was pending on a grant to a new line, a member of the Storthing remarked that, while his constituents had no direct interest in it, they would support the grant, because the wires would drive away the wolves. It is said that, however hungry a wolf may be, he will never go into a spot that is enclosed by ropes stretched on posts. It is stated, as a remarkable fact, that since the first telegraphic line was established, twenty years ago, wolves have never appeared in its neighbourhood.

Telegraphic Addresses.—At the last meeting of the Dundee Chamber of Commerce, it was stated that the Chamber had sent a letter to the Postmaster-General in reference to the charge made for registering telegraphic addresses, which they considered too high, and an acknowledgment of the letter had been received.

Charges for Press Cablegrams.—The *Colonies and India* says that, after all, there appears to be a hitch in the arrangements for the reduction in the tariff of Anglo-Australian press cablegrams. The Eastern Telegraph Company is awaiting the official sanction of Russia, Germany, and India before making the change, which is to commence in January. This, however, can only mean a temporary delay, as those Governments were all parties to the reduction which was agreed on at the Berlin Telegraphic Congress. Mr. Murray Smith has promptly written, on behalf of the Colonies, to Dr. Stephan, the Postmaster-General of Germany, and we may be quite sure that the Eastern Telegraph Company will find no obstacles from that eminent Berlin official to the most speedy inauguration of the reduction in the tariff.

The Protection of Submarine Cables.—A telegram from the Hague says that it is expected that before the ratification of the International Convention regarding the protection of submarine cables, a special Conference will be summoned for the purpose of inquiring into the measures taken by the contracting parties to carry out the provisions of the Convention.

Electrically Propelled Vehicles.—On the 23rd ult., Herr J. Zacharias, Engineer to the Berliner Electrische Beleuchtungs Gesellschaft, gave a lecture before the "Electrotechnischen-Verein" on "Electrical Propulsion for Vehicles, Boats, &c." In the discussion which followed, Dr. Werner Siemens, Herr von Hefner Alteneck and others spoke in encouraging and complimentary terms of Mr. Reckenzaun's tramcar system now in operation in Berlin.

Dirigible Balloons.—General Thayer's system of ballooning has attracted much attention in war circles, and the *Scientific American* of the 26th ult., contains several admirable illustrations of the invention. The inventor's attention has been directed chiefly to the use of the balloon in war. He has devised two systems of dirigible balloons, in the first of which the balloon moves at any level, and entirely independent of the earth, while in the second the plane of motion is determined by means of two wires, denominated by the inventor as the balloon-way, which guide the aerial craft, and by means of an electric current effect its propulsion. In Gen. Thayer's second system, the balloon is directed by two wires or light cables stretched across the country on ordinary poles, with U-shaped iron arms on their tops. The motive power, however, is electricity, generated at the end of the line and transmitted to a dynamo machine on the deck of the balloon through wheels, which are thus impelled along the cables and move the balloon. The buoyancy of the structure supports the entire weight, and the wires of the balloon-way simply transmit the power to the motor, and enable it to be applied for propulsion. It is stated that the balloon can travel at the rate of from 60 to 70 miles an hour, under ordinary conditions of weather. It can be put up very rapidly, crossing rivers, valleys, and swamps without the necessity of intermediate supports. In fact, it appears to be a veritable telpher line.

Burglar Alarms.—Is it not a little strange that electrical burglar alarms are not more generally adopted ? The "scare" which is now at its height might easily be abated and the midnight marauders oftentimes readily caught if householders and shopkeepers would but fit up their establishments with a but rarely failing electric alarm.

Telpherage.—The telepherage system, says our trans-Atlantic namesake, is being laid before the Spencer, Mass., manufacturers with the view of laying a line between the factories and South Spencer, where the main line of the Boston and Albany railroad is met.

Electro-Motors.—The paper which we publish by Mr. Mordey on this subject will be read with more than ordinary interest, as the deductions therein are the results of the author's practical experience.

The Performance of Gas Engines.—In the letter which we publish from Mr. Greenhill, he mentions a gas engine of ½ H.P. nominal as giving 1·2 brake horse-power. We feel interested enough to ask how his measurements were taken, for it appears to us that such a result is unprecedented with such a small motor.

Society of Arts.—We would again remind our readers of the following papers which are announced for reading before the Society of Arts at meetings previous to Easter :—At the ordinary meetings on Wednesday evenings, at 8 o'clock — "Calculating Machines," by C. V. Boys ; "Domestic Electric Lighting," by W. H. Preece, F.R.S. ; "The Experiments with Lighthouse Illuminants at the South Foreland," by E. Price Edwards. In the Applied Chemistry and Physics Section, on Thursday evenings, at 8 o'clock—"Magnetism of Ships and the Mariner's Compass," by Wm. Bottomley, jun.

Christmas Decorations.—At a children's evening party, given by Mr. Albert Kisch, of 3, Sutherland Avenue, W., a large Christmas tree was successfully lighted by means of the electric light, thus giving the whole a most striking effect, without the slightest danger of fire or destruction to the handsome presents borne by its branches. The current was supplied from accumulators placed in the corner of the room, and the work was carried out by Messrs. Woodhouse and Rawson.

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Oil as a Fuel.—Last week Messrs. Cooper & Co. had their establishment in Howard Street, Glasgow, lighted for the first time by means of electricity generated by the Thomson-Houston patent dynamo machine. The noteworthy fact connected with the apparatus is that the steam for the compound Robey engine, which drives the dynamo machine, is supplied from a locomotive boiler, in which oil is used as a fuel. A tank for the oil is erected above the boiler, the oil being carried along in pipes and passed through a valve, where it unites with air drawn in by the suction of a steam jet. The steam pipe and the pipe with the oil are joined at the door of the furnace. The steam spreads the oil inside the furnace, and perfect combustion follows. To attract and distribute the oil steam requires to be raised, in the first place, by a coal fire. This, however, only occupies a few minutes, and thereafter the oil is the only fuel used. The nicety with which the heat can be regulated is also a feature. The boiler is fitted with the Fromentin feeder. It may be mentioned that this is the first installation of the Thomson-Houston plant in Scotland, and that the light is shown by the Thomson-Houston three-branch double arc lamps for running sixteen consecutive hours without renewal of carbons. The machinery has been fitted up by Mr. Richard Millar, of Glasgow.

A New Depolarising Battery Solution. — The Chemical Electric Light and Power Company, of Boston, Mass., has recently introduced a new battery solution which is claimed to possess five times the efficiency, and to perform five times the work heretofore done with bichromate of potash, besides being much cheaper than the latter. The information given in the prospectus of the company is rather vague, it being stated, for instance, that the solution has maintained incandescent lamps at full candle-power for over 200 hours, the quantity of the solution not being stated. We also have the remarkable statement that "the light produced is white, steady, safe, acknowledged by those who have seen it to be soft, bright, and beautiful, equal in all, and *superior in many ways, to dynamo incandescent lamps.*" No doubt the current supplied by the battery charged with the new chemical solution is of a very high quality. The new solution rejoices in the name "Volta Pavia."

A Suggested Rival to the Telephone.—Our readers may remember that in 1884, we described the Clay Telephone system. We now learn from American sources that Mr. Henry Clay is about to introduce a gigantic system of electro-pneumatic transit, which he declares will revolutionise the present system of mail carriage and the transmission of intelligence by telephone. The scheme is one of vast proportions and elaborate detail and is founded on a new plan of transmission by pneumatic tubes controlled and governed by electrical appliances. Mr. Clay last year obtained letters patent on the invention in Europe and in his own country, and is now taking steps, in connection with George W. Bratton, towards organising a stock company to cover the United States and several companies in Europe. The system differs materially from the present pneumatic tube systems in this particular, that whereas at present several tubes are required to run from one central point to those radiating from it, by the new arrangement of electrical devices and switches the carriers are sent from the main tube leading from the central point to the various branches with a great saving of expense in tubing. One line of tube will suffice for all stations, just as do the water mains. Messrs. Clay and Bratton are confident that by this invention they will get even with the Bell Telephone Company, with whom they had such a great lawsuit last winter, since by this new system messages can be transmitted with so much greater speed, secrecy and general satisfaction.

The Daft Electric Motor.—The Daft electric motor is reported to be meeting with immense success on the street car line in Baltimore.

Blondin Outdone.—The rat, whose propensity for nibbling away the gutta-percha covering of insulated wires had already earned for it the distinction of being the *bête noir* of underground telegraphs, has determined to come out in a new *rôle*. Accordingly, one of these interesting animals held some hundreds of people in amusement in Victoria Street, Liverpool, on Saturday last, while it attempted a performance hitherto unprecedented in the annals of tight-rope walking. About half-past twelve o'clock the rat was observed on a telegraph wire running across Victoria Street, endeavouring to cross over the street on the wire. Its progress was very slow, and it was evidently in an exhausted state, from the difficulty which it experienced in clinging to the wire. It is supposed that it had escaped from one of the adjoining provision warehouses on to the roof, and then climbed up the telegraph pole, by which means it got on the wire. There is no official record of the fate of the rat.

Tenders required for Electric Lighting. — The guardians of St. Saviour's Union are prepared to receive plans, specifications, and tenders *inter alia* for lighting their infirmary by electricity. Plans, &c., should be forwarded by 13th January, to Mr. H. C. Jones, clerk, Clerk's Offices, John Street West, Blackfriars Road, S.E. Plans of the building may be seen between 10 and 4, on application to Messrs. Jarvis and Son, the board's architects, 29, Trinity Square, Borough, S.E.

Electrical Apparatus. — We shall endeavour to describe in our next issue a number of electrical switches manufactured by Messrs. Woodhouse and Rawson, for use in electric lighting installations.

The Exchange Telegraph Company and the Stock Exchange.—A petition has been presented to the Stock Exchange Committee for the readmission of the *employés* of the Exchange Telegraph Company to the "House"; and a correspondent writing to the *Times*, points out the advantages to be derived from such a course, if the Telegraph Company undertook, as it recently signified its willingness to do, to cut off "outsiders" from its system. This would be a blow to "outside brokers" and their "bucket shops" which the Stock Exchange Committee must see the advisability of dealing, in its own interest.

The Patent Office.—The President of the Board of Trade has appointed Sir Farrer Herschell, the Earl of Crawford and Balcarres, and Baron Henry de Worms, M.P., to be a Committee to inquire into the duties, organisation, and arrangements of the Patent Office under the Patents, Designs, and Trade Marks Act, 1883.

Patents.—The number of applications for patents during the year ending December 31, 1885, amounted to 16,101, being a decrease on the previous year of 1,009.

Electric Lighting Bill.—The time for depositing private Bills in Parliament has expired, and the only London Bill deposited relating to the electric light is one promoted by the West London Electric Lighting Company, which asks for an extension of time within which to carry out the powers conferred by several provisional orders, which have from time to time been granted to the company under the Electric Lighting Act of 1882. The company also seeks to exempt itself from certain provisions in that Act, which define the terms upon which electricity shall be supplied.

The Alleged Fraud by an Electrician.—Charles Stuart Cochrane, an American electrician, who was, as we have previously stated, charged at the Mansion House with personating the trustees of certain stock of the Artizans', Labourers', and General Dwellings Company, was on Wednesday committed for trial at the next sessions of the Central Criminal Court.

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The Snowstorm and the Wires.—The somewhat sudden and heavy fall of snow early on Wednesday morning proved of serious inconvenience to the telephone and telegraph people. During the morning wires broke in all directions, and in some places where the wires were thickest the broken ends hung in festoons about the houses, while in different quarters, several of the wires fell into the roadway. We have not heard yet, however, of the appalling list of fatalities which we have been told to expect as soon as a snowstorm should break down the wires.

One accident, indeed, has occurred, and it was of rather a singular character. As a man named Ambrose was about to enter a tavern in Clerkenwell Road one of the lines overhead broke asunder, and the end penetrated his face, just beneath his right eye. The manager of the house nipped the wire with a pair of pliers, but failed to extract the remaining piece. Ambrose was taken to St. Bartholomew's Hospital, where his injury was successfully treated.

The Post-Office give notice of probable delay generally on all telegrams, and of considerable delay to offices in the South, South-East, South-West, and West of England, and to South Wales; also to the outlying suburbs of London.

The Submarine Telegraph Company give notice of delay to the Continent.

From various parts of the country accounts come to hand of the breakage of telegraph and telephone lines, and in many places a temporary interruption of communication has resulted.

The secretary of the United Telephone Company writes:—"Considering the heavy fall of snow that has taken place, the damage done to our wires has been comparatively slight, and, with anything like favourable weather, we shall have all communication re-established in the course of a few days."

Mr. Charles B. King, who writes to the *Times* as under, is very positive as to the dangers of overhead wires, and the ease with which they might be placed under ground:—"The severe snow storm which has visited the metropolis has once more made manifest the danger and great inconvenience of overhead telegraph wires. The condition to-day of the network of wires spanning the crowded thoroughfares is lamentable to witness, and suggests the query how the authorities could ever have permitted such an interference with public rights. An eminent judge has laid it down that anything coming by *vis major* between the line of earth and heaven is an infraction of the rights of him to whom the soil belongs. The inference in the present case is obvious, and, as the remedy is so simple, may I, in the interests of the public, draw attention, through the *Times*, to the imperative duty of the Metropolitan Board of Works and the Commissioners of Sewers of the City of London to do something more than talk and sending commissions to Continental cities to see how much we are behindhand in such matters. Speaking as an engineer, I may say it is the easiest possible thing to arrange our metropolis and city in underground sections for the disposal of telegraph and telephone wires."

We would suggest that Mr. King should submit plans for carrying out this easiest possible thing? We live and learn!

The Determination of the Ohm.—In the *Phil. Mag.* for this month Lord Rayleigh discourses upon Prof. Himstedt's determination of the ohm.

Galvanic Batteries.—In the latest number of our transatlantic namesake, Prof. Van der Weyde, the President of the New York Electrical Society, gives a chronological review of the gradual development and successive improvements of galvanic batteries. He describes the Fuller battery, which is so much employed in this country, and then goes on to say:—The Higgins battery is about the same as Fuller's, only he uses more sulphuric acid. Apparently, then, there is about as much distinction between these cells as between Cæsar and Pompey, who were said to be very much alike, especially Pompey.

Patents in 1885.—Writing to the *Times* upon this subject and commenting upon an article published in that journal, Mr. John Imray, President of the Institute of Patent Agents, says: "The suppression of abandoned provisional specifications, as well as other amendments of the law, was enacted in consequence of suggestions made to Sir F. Herschell, not by the Society of Arts, but by the Institute of Patent Agents, who, as a body, may claim some merit in having made the machinery of the new Patent Law work somewhat smoothly, a merit courteously acknowledged by the Comptroller of Patents in his official report for 1884. Many inventors will, no doubt, regret that they have been induced to trust to their own skill guided more or less by the officials in the Patent Office, in the preparation of their specifications; but how, as a result of this, 'an abundant crop of litigation hereafter' is to benefit patent agents does not appear. The patent agent, except in those cases in which he may be employed as an expert, has little to do with patent litigation; his principal business is, as far as possible, to prevent it by applying his skill and experience, his knowledge of patent law and decisions, and his general acquaintance with antecedent inventions, to keep the inventor clear of the pitfalls which open on all sides of the path that has to be trod by the patentee. Inventors have above all reason to regret that the machinery which existed in the Patent Office for the preparation of indexes and abridgments is allowed to stand still. The search for a needle in a bundle of hay is child's-play compared with that for an invention among our patent records as they now are, uncondensed, unabridged, and unindexed in any rational way."

Underground Wires.—An idea of the work before the New York Electrical Subway Commission may be gathered from the fact that 103 different plans, with models and descriptions, were submitted to the board, and on each of these a written report has been made by a mechanical engineer of the city. Out of the whole number a very small percentage, indeed, is found to possess merit enough to receive the attention of the commission, which will meet soon and from the few plans of merit will select the one which in their opinion posssses the necessary requirements for underground wire work in New York City.

Electrical Papers.—"A Note on the Electromotive Force of Certain Tin Cells," by E. F. Herroun, of King's College, London; "Note on the Calibration of Galvanometers by a Constant Current," by T. Mather, of the City and Guilds of London Central Institution; and some Notes by Profs. Ayrton and Perry on Dr. Lodge's paper "The Seat of Electromotive Force in the Voltaic Cell," are published in the current issue of the *Philosophical Magazine.*

Copper Resistance by False Zero Method.—The papers on this subject which were published in the ELECTRICAL REVIEW towards the end of last year, have been reproduced in our interesting little contemporary, the *Monthly Correspondent*, of Madeira.

Dynamo Machines.—In *La Lumière Electrique*, for the 2nd inst., W. Cam. Rechniewski writes learnedly on the study of dynamo machines.

Determining the Weights of Bodies.—A very interesting article by C. Decharme, on the application of electricity for determining the weights of bodies, appears in the same number of *La Lumière Electrique* as that to which we have referred as containing a study of dynamos.

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A New Engine.—In our last issue we announced the registration of the Continental Etéve Engine Company, Limited. From our own experience of this motor, extending over a period of nearly two years, we do not hesitate to say that properly managed we believe the Etéve engine has a great future before it. We shall be pleased to give any of our readers what particulars they desire respecting its performance if they will favour us with a call.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Telegraph Improvement Company, Limited.—The annual return of this company, made up to the 28th ult., was filed on the 2nd inst. The nominal capital is £100,000 in £1 shares. 15,006 have been taken up and the full amount has been called and paid thereon. Registered office, 10, Austin Friars.

Buenos Ayres Electric Light Company, Limited.—The annual return of this company, made up to the 30th ult., was filed on the 1st inst. The nominal capital is £100,000, divided into 9,986 shares of £10 each and 70 founders' shares of £2 each. The only shares taken up are the founders' shares, and these are considered as fully paid. Registered office, 1, East India Avenue.

CITY NOTES, REPORTS, MEETINGS, &c.

The Anglo-American Telegraph Company Shareholders' Association.

SEVERAL shareholders who have been dissatisfied with the action of the directors of the Anglo-American Telegraph Company in making large annual additions to the reserve fund, have for the last twelve months been acting as a committee for the purpose of opposing the directors, and forming an association of shareholders. This committee, being self-elected, convened a meeting, which was held on Tuesday at the Cannon Street Hotel, of those who have supported them, for the purpose of securing the appointment of a permanent committee by the members. Previous to the meeting the following circular had been circulated, bearing the signature of Mr. J. Stockdale, as hon. sec.:—

The provisional committee of this association desire to acknowledge with thanks the large amount of support received in response to their appeal to shareholders by circular on the 24th July last, which they confidently trust will be *continued*, until the just claim of shareholders, to the full division of nett earnings by this company, is enforced.

In accordance with the usual custom, the proxies were presented at the office of the company more than 48 hours before the time appointed for the general meeting, but were refused, on the ground that, according to the articles of association, they should have been deposited 48 hours before the *day* of said meeting. The directors availed themselves of this quibble to evade joining issue with the committee on their resolution, viz.:—"That no further addition to the so-called renewal fund shall be made from the 1st of the present month, with the exception of the accruing interest."

Nevertheless, the resolution was put to the meeting by Mr. Thomas Smith, of York, and carried by a majority of the shareholders present. The directors have, notwithstanding, refused the urgent wishes of the proprietors to discontinue any further addition to this fund, and saving the reduction of £50,000, which has been assented to, and which was absolutely necessary, in order to pay any dividend at all, they have now, for the third time, under cover of the articles of association, ignored the reasonable demands of the stockholders in public meeting assembled.

Having regard to the fact that the whole of the repairs and maintenance of our four cables are defrayed out of revenue, exclusive of the appropriation (including interest) of £130,000 per annum to renewal fund, that two new deep sea cables, the 1874 and 1880, have been replaced out of our income, and that under provision of the joint purse agreement, a period of 12 months is allowed for repairs without suffering the loss of any portion of our income from the joint receipts; the sum of £850,000, which will, at least, be the amount standing to credit of the renewal fund next January, is an overwhelmingly sufficient provision for any contingency possible to be foreseen.

In view of the fact that the combined cable power is more than equal to *double* the requirement of the traffic, we submit that we should not suffer ourselves to be *mulcted* any longer for the purpose of increasing this colossal renewal fund, but jealously guard against the possibility of its being squandered by any board of directors.

The articles of association having been drawn up entirely in favour of the directors, without due regard to the just rights of shareholders, it is imperative these articles should be revised in the interest of the proprietors—with this object—also for the purpose of electing a committee, the present committee being provisional only, you are respectfully invited to attend a meeting of the shareholders of this company, at Cannon Street Hotel, on Tuesday, 5th January, 1886, at 3 o'clock p.m.

It is proposed that the qualification for members of the committee of the Shareholders' Association, shall be the holding of a minimum of £5,000 stock; any stockholder possessing the necessary qualification, willing to serve on this committee is desired to communicate with the hon. secretary.

The practice of the board of directors in sending with the half-yearly report to shareholders, a *stamped* form of proxy in their own favour, the expense of which is not defrayed by themselves, but taken from shareholders, is a course of proceeding which cannot be too strongly condemned, and for which an early remedy should be provided.

Mr. Thomas Smith, of York, who has at several recent meetings of the company moved resolutions for the discontinuance of the additions to the reserve fund, was voted to the chair. He said that the committee which had been acting for the last year was merely self-elected, and they now thought it was time for the shareholders themselves to elect from their own body a committee to represent them upon any proper occasion. As they were well aware, at the meetings of the company any single person getting up to make a proposition was merely pooh-poohed; but where there was unity there was strength, and they hoped to change all that. He might say that already, in consequence of the pressure they had brought to bear on the directors, they had conceded £50,000 from the large amount they had hitherto added to the reserve fund. That fund would at the end of the half year, if the directors carried out their proposition, amount to £850,000. The committee considered that it was absolutely necessary that the shareholders should now take some steps to prevent any further addition to that sum, with the exception of the accruing interest. There was now quite sufficient to lay two new cables, and there must occur some very unfavourable circumstances that would require two new cables to be laid within one twelvemonth. If anything should happen within a twelvemonth, it did not necessitate any loss of receipts on their part; they had twelve months, under the pooling arrangement, in which to re-lay the cable. This association was formed last February, after the meeting then held. At that meeting he (the Chairman) brought forward a motion that no further sum be added to the renewal fund. If the idea he suggested had been carried out they would have had a renewal fund of £750,000, and the company would have been enabled to pay something like 3½ or 4 per cent. But Viscount Monck did not consider it a proper thing to do, and carried out his idea of adding £150,000. He had, however, since modified his views, and only added £100,000. After that meeting in February, Mr. Stockdale, Mr. Jackson, and Mr. Brown called on him and invited him to assist them in forming an association. To this he consented, the association was formed, and they had addressed themselves to the shareholders three times. This was no small thing to do, as there were between 5,000 and 6,000 shareholders. They had received some very agreeable responses and encouraging remarks from a great many shareholders. They were now come to the period when they thought they should ask the shareholders to help them, and to form a committee from the body of the shareholders, any gentleman holding £5,000 of stock to be eligible to act. The expenses which the committee had incurred amounted to £34 18s. 8d., and they had received from the shareholders subscriptions of 5s. each to the amount of £20 12s. 6d., so that there was a balance of £14 6s. 2d. due to the treasurer, Mr. Stockdale. They had thought that it would be necessary, in order to provide for the expenses that would have to be incurred, to have a *pro rata* contribution of 1s. per cent. on the holding of the members of the association, with the reserve that the minimum should be 5s. and the maximum £5. He would propose that a committee be formed to replace the present one, which was only provisional.

Mr. Jackson seconded the proposition, and said the committee represented getting on for a million of stock, with their own stock and the proxies entrusted to them. The result of their efforts was evident in a dividend, a very small one, it was true, but one which would have disappeared altogether if the directors had not been called to account. The articles of association, he had been told, were so drawn as to leave everything in the hands of the directors and exclude the shareholders altogether. The Anglo-American Company originated with a small number of capitalists, who subscribed £600,000 to a desperate undertaking. The 1858 cable had been abandoned, and the 1865 cable had broken after only one message had been sent by it. It was thought very desirable that there should be a cable connecting this country with America, and a small meeting of capitalists was held and the money was subscribed in something like two hours. In the articles of association which were drawn up they took every care of themselves. But those articles still stood as the articles of the

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present company, which was not a company of capitalists; their board, indeed, represented a very small amount of capital and the shareholders had grown from a few gentlemen to 5,500 members; and yet those articles gave the directors an autocracy and almost an irresponsible power. It was only necessary for the shareholders to place it before the board that they were determined that that state of things should not continue; and if they (the shareholders) did not look after their affairs they deserved to lose their dividends. The original founders of the company received 25 per cent. per annum for the loan of their money, for they would not become the cable company, and 100 per cent. redemption money if they handed their undertaking to the company intact. That redemption money they received, and he thought they got not a bad return for their loan—£1,200,000 for £100,000 in twelve months. He told them this to show them that there was a necessity for the shareholders to wake up to their position, and to tell the directors that they have made the company so safe that whatever might arise, putting competition aside, there would be no requirement for anything like the amount they possessed. That the directors did not always think there was need for such large additions to the reserve fund was evident from the fact that in 1872, when there was a great prospect of both cables being lost, they did not put more than £60,000 to reserve. Mr. Cyrus Field had told them—and probably no gentleman living was a better judge of the value of their property or of its quality—that as possessing the shortest route to Newfoundland, their position was really a very good one. They would remember, too, that last year, when all the newer cables were broken, the Anglo-American cables carried the whole of the traffic for months. That must be evidence to them, as it was to him, that they did not require any more renewal fund. What they wanted of the directors was simply this—to stop this drain on their resources and give them their just rights; add the interest to the fund, if they would, but give the shareholders the net earnings. He took that opportunity of thanking Mr. Stockdale, who had taken a great amount of pains and spent a great deal of time upon the affairs of the association.

Mr. Prust could not quite fall in with the views of the previous speakers about the reserve fund. He had sustained a very serious loss in the company, and, viewing the subject on all sides, considering that they had now £850,000, he thought they ought to make it the round sum of £1,000,000. This would give them a solidity of which nothing could deprive them. They knew that all bank shares stood at an enormously high premium, simply because they had a large backbone. This money which formed the reserve fund came almost entirely out of the hands of the deferred shareholders; the preferred had suffered nothing. He was not quite sure that the company would not be dissolved, or be continued in another form, and he had taken the opinion of an eminent counsel upon the question as to who would be entitled to the money in case of a dissolution, and had been assured that it would belong to those who had subscribed it; supposing an American company purchased the undertaking, or it was liquidated, the reserve must be returned to those who contributed it. He thought they could not have very much longer to wait, and he thought the best policy was to let the reserve fund go on. They would recollect that at the last meeting he got a resolution passed and a promise from the directors that they would not use any of that money without consulting the shareholders. There were eight cables in the pool, but only four were being used. This was due to the contraction of commerce between this country and America, but it was evident that there was no necessity for another cable, so that they need not alarm themselves upon that head. He thought their property stood in the market at a most ridiculous price. Speaking of the articles of association, he thought there was great need for an alteration of them, and, with regard to the proxies, he hoped one of the lately returned Members of Parliament would soon bring in a Bill to suppress that iniquitous system.

Mr. Newton said he had fought many years against the board upon some of the questions with which the association proposed to deal, but he had given up his efforts many years ago. It would be necessary for them in the first place to turn their attention to procure an alteration in the articles of association. He would advise them, in order to carry an adverse vote at the meeting, to move an amendment to the report, passing it entirely with the exception of obnoxious paragraphs and the items spent in proxies. The resolution must be carefully worded, so that the chairman could not refuse to take it on the ground either that it was a direct negative or that it was out of order. He had again and again pointed out to the directors that the manner in which they used the proxies entrusted to them was a scandalous procedure. As regards the dividend, it was a delicate matter, because the interests were of so conflicting a character. Mr. Prust admitted that the only interest he took in the reserve fund was in the liquidation of the company. His (Mr. Newton's) interest, as a preferred shareholder, was not in the same direction; but he desired to say nothing from a personal point of view. With respect to the board, he did not wish to say a single word against their qualifications, but he would say they were vastly overpaid. Those of them who were in business knew that their profits had been reduced by 50 or 80 per cent., yet their earnings as directors of public companies had suffered no diminution, whilst those for whom they worked had suffered very considerably. There ought to be some connection between the prosperity of the shareholders or their adversity, and the prosperity or adversity of the directors. He did not mind paying directors very well indeed when they were paying good dividends.

Mr. Davison said that from the remarks of the speakers who had preceded, and from his own careful observation, he gathered that there were really two questions demanding their serious consideration: one the articles of association, which, apparently, although they may have answered the purpose of the company originally, were quite inadequate to the requirements of the shareholders at the present time; the second was, the magnitude of the reserve fund. With regard to the former, one of the speakers had mentioned that they might be altered by a resolution very carefully worded. From his experience, he was afraid they could not rely upon that being carried out; but if they came to the conclusion that the articles of association ought to be altered, the proper way to proceed would be to hold an extraordinary general meeting of the company for the special purpose, and, as it would probably be rather difficult to carry out the alterations at the time, a committee might be delegated to go into the question carefully. There could not be a shadow of a doubt that the reserve fund was really larger than was required. He had long ago come to the conclusion that 10 per cent., or £700,000, would be a very proper sum for this company to lay aside for such contingencies as called upon the reserve fund. Were the fund less than that he should be one of the strongest to advocate building it up; but he thought they ought to take steps to prevent its getting any larger; and it was apparent that the great body of the shareholders were anxious to stop any increase to the reserve, so that the deferred shareholders might have something like justice meted out to them.

The Chairman said Mr. Prust made a slight mistake in saying that the reserve fund was under the protection of the shareholders. The directors did not submit to the resolution that it should not be used without the consent of the shareholders.

Mr. Prust: But my resolution was carried.

Mr. Jackson: You were defeated on the poll.

Mr. Prust: I was under a misapprehension, then.

Mr. Davison thought they should be cautious in recording a resolution condemnatory of proxies; they should not take too warm a view of that subject for the simple reason that proxies really represented absent shareholders, and as a general rule the body of men present at a meeting might be supposed to be only one-tenth of the entire body, and it was rather an error to say that the other nine-tenths should not record their opinion by sending proxies. Still, he was aware that proxies were improperly used occasionally.

Mr. Griffith said when they considered that the cables in existence were more than sufficient to do double the amount of business, they must think that the time had come when their large insurance fund need not be increased. There were other cables beside their own, and those cables were able to carry on the business even if the cables of this company were broken. It might or might not be wise to allow the directors to issue proxies; but if they did so they ought to pay for them themselves. The articles of association had been very unfairly drawn, giving undue power to the managing partners. When they were first drawn there was one merit about them, for there was a stipulation that the reserve fund should be used not entirely for insurance but partly for the equalisation of dividends and other purposes. But, recognising that that gave some power to the shareholders, the directors called a meeting, and that was altered. They therefore had something to return to; their doctrines were not entirely of the socialistic order, for they wanted those rights which they had once possessed, and which they would possess again if they only had courage to persevere.

Resolutions were then submitted appointing Messrs. Davison and Griffith members of the committee; and the four gentlemen who had been acting as a provisional committee, Messrs. Smith, Brown, Jackson and Stockdale, were also appointed. No other business was brought forward, and the proceedings terminated in a vote of thanks to the chairman.

Western and Brazilian Telegraph Company, Limited.—It has been decided by the directors to recommend a dividend of 2½ per cent. for the year ended September 30th last, placing £10,000 to the reserve fund.

Volta Electrical Company, Limited.—The creditors of this company are required to send in the particulars of their claims to the voluntary liquidators by the 11th inst., and those of the London and Globe Telephone and Maintenance Company, Limited, by the 14th inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of December was 3,023, estimated to produce £2,450, against 3,001 messages, producing £2,553 in the corresponding month of last year. The receipts for the month of September, estimated at £2,100, realised £2,160.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 1st were £2,150, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for December, 1885, were £20,280; from 1st January to 31st December, 1885, £284,720; for the corresponding months of 1884, £276,230; and of 1883, £251,480.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of December were £1,754, against £1,748 in the corresponding period of last year.

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NEW PATENTS—1885.

15701. "Insulation of electric and line wires." A. E. GILBERT. Dated December 21. (*Complete.*)

16009. "Measuring electric currents of the continuous, interrupted or intermittent kind." R. D. SMILLIE. Dated December 30.

16031. "Voltaic batteries." D. T. PIOT, H. CHARLES, A. LEVY. Dated December 30.

16038. "Distributing electric currents." C. D. ABEL. (Communicated by Siemens and Halske.) Dated December 30.

16088. "Carpet sewing machines." A. ANDERSON. (Communicated by Singer Manufacturing Company.) Dated December 31.

16099. "Mechanical telephone." L. N. LOEB. (Communicated by C. Loeb.) Dated December 31.

1886.

25. "Cable for the production of induced currents." H. J. HADDAN. (Communicated by A. Arndt.) Dated January 1.

40. "Mechanical telephone." W. MCPHERSON. Dated January 1.

42. "Volta-inductors." C. D. ABEL. (Communicated by Siemens and Halske.) Dated January 1.

56. "Electric governor applicable for purposes of regulation generally." G. E. DORMAN. Dated January 2.

68. "Holders for supporting incandescent electric lamps and their shades." A. SWAN. Dated January 2.

154. "Dynamo-electric machines." H. J. ALLISON. (Communicated by E. Thomson.) Dated January 5. (*Complete.*)

200. "Mechanical telephones." P. EWENS. Dated January 5.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

12300. "An electric locomotive." J. C. MEWBURN. (Communicated from abroad by Marcel Deprez and M. Leblanc, of Paris.) Dated September 11. 6d. The locomotive is composed of a dynamo-electric machine of special construction. It actuates

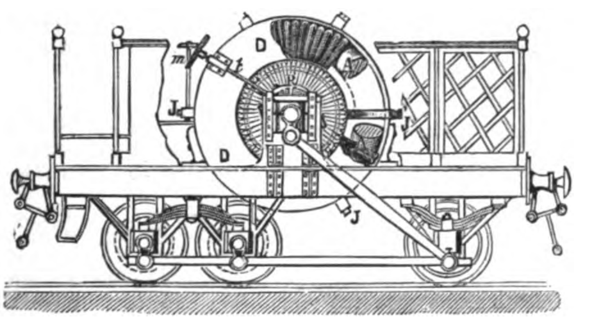

FIG. 1.

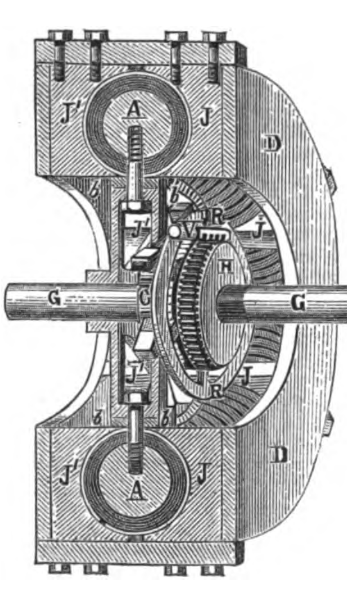

FIG. 2.

by the intermediation of cranks and connecting rods, two or more pairs of wheels coupled together in the usual manner (see fig. 1). In this way the driving wheels and the induced body of the dynamo-electric machine rotate with the same angular velocity. Two pairs of the wheels (those at the left hand of fig. 1) are of special construction. Their tyres can be magnetised, and thus provide increased adhesion when necessary, especially when starting or when ascending inclines. As these pairs of wheels should be placed near together in order to provide for a uniform distribution of the weight of the apparatus on the wheels which support it, it is necessary that the different parts of the locomotive, especially the springs, should be arranged accordingly (see fig. 1). The dynamo-electric machine is arranged in such manner as to develop as great a power as possible for a given weight which is necessary for obtaining a good tractive force. The ring, A, A (fig. 2), covered with wire is carried by a wooden support, *b*, *b*, which is itself supported by an internal wheel, or two circular cheeks of non-magnetic material. This wheel, or these cheeks, are keyed on a shaft, G, G, to which the collector, C, is also fixed. The inductor of this machine is formed of two open discs of iron, D, D (figs. 1 and 2); their width is equal to the thickness of the covered ring; they carry at intervals projecting pieces, J, J, J; J^1, J^1, J^1; which embrace the ring (see figs. 1 and 2); these pieces are of flat form, and their mean plane passes through the shaft, G, G. They are at equal distances from each other and of even number.

1885.

1281. "Improvements in the construction of electro-motors." D. T. PIOT. Dated January 29. 8d. The object of the invention is to increase the power of electro-motors, and this the inventor effects by enlarging the polar surfaces of the field magnets and the armature, and by so connecting the bobbins of the armature and the field magnets with the battery that the exciting current may act equally upon each with the best effect.

1288. "Improved means for establishing electric connection between surfaces in relative motion, applicable to the collectors of dynamo machines." G. FORBES. Dated January 29. 6d. According to the present invention the inventor is able to take off the current from the circumference of a disc by means of plumbago or hard carbon applied with moderate pressure to the disc.

1444. "Improvements in cable telegraphing at great distances and in apparatus therefor." P. JENSEN. (Communicated from abroad by E. Baron von Taund-Szyll, of Graz.) Dated February 2. 8d. The receiver consists of a tightly closed box containing in an interior compartment a powerful source of light, the rays from which can pass out through two small narrow slits. The releaser consists of a small spool frame similar to Sir William Thomson's syphon recorder, which is suspended in a silk fibre, and is movable within a very powerful magnetic field. The small frame has a lower prolongation or shutter, which is of triangular section, and which hangs so in front of the partition of the box as to cover exactly the slits and thus also, when the frame is at rest, prevents the light rays from the lamp from passing out through the slits. But when the cable current passes through the wires into the coils of the spool of the frame, then the frame will be swung lightly to the left or right, all according to the polarity of the current, and thus be brought nearer to one of the magnet poles. As the lower prolongation or shutter partakes of this motion, it will open for the slit and let the light rays out of the box. The rays of light act on selenium cells which are in connection with batteries and relays and a recording apparatus. (See REVIEW for December 12th, 1885.)

CORRESPONDENCE.

Telephone Patents.

It occurs to me that the public generally would be greatly benefitted and enlightened by the publication of the patents held by the United Telephone Company upon which they base their claims to a monopoly in telephones. There are certainly thousands who take a professional interest in the matter, and tens of thousands who are interested in a different way. It is of course an easy thing, if one can spare the time, to go to the Patent Office and look through all the telephone patents that have been filed, but the time required is more than most of us can spare, while, unless we can also examine all the disclaimers that have been filed from time to time, our labour would be almost useless.

The ELECTRICAL REVIEW has done much valuable work in publishing and discriminating between *bonâ fide* claims and patents and bogus ones, and if it would undertake the publication of what I have suggested, electricians and capitalists will be benefitted to a degree that it is difficult to estimate. It is a matter of certainty that there are some forms of telephones, such as the "English mechanic" and the "Glasgow" which the public are free to use, but the peculiar points of these instruments are not generally understood, and an explanation of them would be much appreciated.

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I am fully aware of the great labour and expense entailed by a complete and thorough investigation and publication, but it has now become a necessity that it should be undertaken, and its importance is such as to lead to a confident hope that the ELECTRICAL REVIEW will not shrink from the task. It could not be in better hands.

H. C.

December 31*st*, 1885.

[During the past four years the matter of telephone patents has been very thoroughly discussed in the pages of the REVIEW. If we undertook to do that which our correspondent suggests, the result would be simply a reproduction of old matter, and we are not quite convinced that our readers would take kindly to such a re-hash, although placed before them as a single dish.

The instruments which "H. C." mentions as being free to the public are known to the most minute details to our regular subscribers, but unfortunately these apparatus cannot be practically employed interchangeably as transmitters and receivers. The transmitter is the rock on which all those who have tried conclusions with the United Telephone Company have split. However, we shall be pleased to learn the views of other of our readers who may be interested in the progress of the telephonic industry.—EDS. ELEC. REV.]

Secondary Generators or Transformers.

In your issue of the 12th inst. we find a "would-be" reply to our letter, which you kindly published in your issue of the 28th ult.; but that "reply" of Messrs. Gaulard and Gibbs can by no means be regarded as such, for the said gentlemen pursue a rather singular proceeding in the whole course of the controversy they have judged convenient to provoke.

They begin by trying to defend the pretended better qualities of their secondary generators; later on their complaints turn principally against our "usurpation" of their patent rights, and now, being convinced of the absolute groundlessness and untenableness of both pretensions, they draw forth quite new things which do not in the least interest the readers of a technical journal, and in all their letters they ride on their usual hobby-horse, viz., the report of the International Jury of the Turin Exhibition.

With regard to this last question, we have already made our remarks in a foregoing letter, and we would only add that it proves hardly in favour of Messrs. Gaulard and Gibbs, if two of those gentlemen who have co-operated in a most prominent manner with regard to the report alluded to, finish by giving preference to our transformers, the one of them, Prof. Ferraris, by proving in a later report the superiority of our apparatus, the other, Prof. Colombo, by employing them for an electric light installation to be carried out by his company.

Messrs. Gaulard and Gibbs, in order to refute our assertions, refer in their last letter to a specification of Dr. John and Dr. Edward Hopkinson, of the 24th October 1884. We cannot understand what the reference to that specification should prove against us; we think this could only prove that Dr. Edward Hopkinson, on his visit to the Turin Exhibition, has equally learned from Mr. Gaulard how a transformer should *not* be constructed. As regards ourselves, we could learn nothing whatever by the specification alluded to, as provisional specifications are held secret in England —of which fact Messrs. Gaulard and Gibbs should be aware—and the complete specification of the invention in question being dated July 27th, 1885.

As to the remark of Messrs. Gaulard and Gibbs, that there remains nothing to Mr. Zipernowski but the experience "how to construct alternate current machines, which he learnt in the good school of Messrs. Siemens and Halske," we decline entering into this matter, as this is quite out of the way of the controversy raised by Messrs. Gaulard and Gibbs, and because we are not willing to enter into disputes about new matters, as we see that the said gentlemen, in ignorance of the matter, always leave the matter.

Messrs. Gaulard and Gibbs finish by referring to an interview they had had with Mr. Blathy at the Turin Exhibition, and they add to this the "surprising" revelation that they have a letter from Mr. Blathy which will be produced by them at the proper moment. We don't know what the interviews with Mr. Blathy and an interesting letter of the same gentleman might have to do with this controversy; we are only surprised that Messrs. Gaulard and Gibbs have not published that letter at an early period; perhaps this would have rendered unnecessary the whole controversy which, we fear, may have become already rather tiresome for the readers of this journal. As the matter stands, we must have patience in awaiting the moment Messrs. Gaulard and Gibbs will judge proper for the publication of private letters, and we presume that Mr. Blathy will not fail to give the explanations which might eventually be necessary.

We herewith declare that as the method of Messrs. Gaulard and Gibbs in treating public disputes has rendered sterile the present controversy, and as we are convinced that those of your readers for whom the matter in question might have some interest, no doubt have already constituted for themselves an opinion as to the state of things—we have neither cause nor desire to pursue this controversy.

We thank you for having kindly permitted us to publish our letters in your esteemed journal.

Charles Zipernowski,
Max. Deri,
O. T. Blathy.

Budapest, *December* 27*th*, 1885.

Domestic Electric Lighting.

In accordance with a promise made to you at the time you inserted in your valuable journal some particulars of my installation at Sydenham, I beg to forward figures showing the working cost for the six months ending December 31st, 1885.

The installation now consists of 2—95 v. 10 C.P., 35—47 v. 10 C.P., 275—95 v. 20 C.P., 6—42 v. 30 C.P., 5—95 v. 50 C.P., 2—95 v. 100 C.P., Woodhouse & Rawson lamps, in all 325 lamps. This number is distributed over three houses.

The current is delivered to the lamps by an E.P.S. battery, consisting of 50 three horse-power cells of the ordinary L type plates; these are charged by a number five Phœnix dynamo, driven by an 8 horse-power Otto gas engine.

The installation has cost, without fittings, £1,500. The cost of working it during the above-mentioned period has amounted to £92 1s., made up as follows:—

	£	s.	d.
Gas	60	6	0
Oil and cotton waste	2	9	0
Trueing commutator	1	7	0
2 pairs brushes	0	14	0
Renewals, 31 lamps	7	15	0
Wages	19	10	0
	£92	1	0

The discharge of current naturally varies very considerably during the evening; but, except on special occasions, does not exceed 60 ampères. In the month of July I temporarily added 100 20-C.P., 8 50-C.P., and 4 100-C.P. lamps for the use of the stage in Westwood House. On the evenings when these were used the discharge went up to 90 ampères, the house lighting being reduced as much as possible during the time these extra lamps were lighted. I have got on fairly well with the accumulators; the chief trouble has been brought about by rather frequent short circuits. The cells, in one or two mechanical details, require material improvement. The India rubber plugs used for separating the plates do not answer at all well; some harder material is necessary for this purpose, as should any undue pressure arise, which is frequently the case, from a section getting slightly

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out of the upright, for instance, the soft rubber is squeezed out of its place, the plates come into contact, and mischief is the consequence. I have also found it necessary to add washers to the bolts and nuts used for coupling the cells, as in screwing the nuts up tightly in order to obtain perfect contact, which is of the highest importance, I found the brass nuts were inclined to cut into the lead of which the lugs are made. The scaling off of the paste from the plates is also likely, I believe, to be a cause of trouble. After a very short time a heavy deposit of this scale is formed in the bottom of the cell, bringing about a passage for the current and possibly, in bad cases, an absolute short circuit. The question of efficiency in secondary batteries has, apparently, not been made the subject of sufficient enquiry. It is, I understand, said to be 90 per cent. I have no opportunity of testing the question, but I can only say that I have to run the engine from 9 to 3 during the day and from 4 to 10 in the evening. Our charging current would average 50 ampères. This should give 600 ampère hours. The discharge during the evening certainly does not exceed 300 ampère hours, yet for this result it is quite necessary to charge as above stated. This shows a loss of just 50 per cent. I should add that the engine does not run on Sundays; the discharge is then somewhat lower. I was advised to run the engine in the evening during the heaviest part of the discharge by the makers of the battery, on grounds of economy, being assured that I should effect a saving in gas to the extent of 50 per cent. As to the time these cells are going to last, it is impossible to say with any certainty; mine appear to be still in fair order, although the efficiency appears to be lower than when they were first put in. They have now been in use exactly 12 months. I was assured by a gentleman well known in the electrical world, that after six months use they would be useless; this statement has, fortunately for me, proved incorrect.

I have written at some length on this question because I feel it is chiefly by the interchange of experience of users of accumulators that we may learn to overcome the many difficulties surrounding them. The question is a vital one to all interested in the progress of electric lighting. No installation is complete without a battery; no successful domestic installation is possible without one.

The machine I have been well satisfied with; it is well and strongly made. Its efficiency might, however, be rather higher. It gives above eight available E.H.P. for the 12 break-horse-power supplied to it.

The lamp renewals are higher than they should be. Eight lamps have been smashed by servants and others; the remainder have broken down by disintegration of the filaments.

The amount charged for wages is paid to a lad of seventeen, who has had entire charge of the installation for the last nine months. He knew nothing of electric lighting when he came to me; in a few days he had learnt all that was necessary for him to know.

This communication has assumed greater proportions than I had anticipated; my excuse must be that the subject is an important and interesting one, and should therefore be acceptable to your readers.

Aug. J. Littleton.

Sydenham, S.E., *January 5th* 1886.

I read with much pleasure the account in last week's issue of the installation for domestic lighting. Perhaps my experience of a still smaller plant may interest your readers. In August, 1884, I decided to light my house by electricity, and for this purpose I put in one of Crossley's ½ H.P. gas engines and a small dynamo. I live in a terrace, hence I was at first rather anxious if the working of the machinery would annoy my neighbours; but as the engine and dynamo were placed in an outhouse in the yard, the size of the room only being 8 feet long by 5½ feet wide, the noise was not troublesome. At first the exhaust from the engine was rather objectionable, but I entirely overcame this by putting a bend on the pipe to discharge downwards, and tying a piece of a sack round and round the pipe, not to prevent the discharge entirely, but to allow it to percolate through the folds of the bag. This entirely overcame the noise. The total number of lights in my house is 18. Of these, 14 are of 41 volts (16 C.P.), and 4 are of 82 volts. The dynamo is 50 volts. It is obvious that the 4 lamps of 82 volts get a very small amount of current, and give but a very faint light. This is intentional, as they are only used as night lights in the bedrooms, and where a faint light is desirable. Parallel with these 82 volt lamps are others of 41 volts, each being actuated by a switch, consequently when a brilliant light is required in the bed room, the lower resistance lamp is switched on; the "dim" lamp has another advantage, namely, indicating where the switch for the bright one is situated. I have often been perplexed, in hotels where the electric light is employed, to find the switch in the bedroom when all was in darkness.

My gas engine gives off (by actual brake tests) 1·2 H.P., and the gas used for this power is 42 feet per hour, *including the igniting lights.* The price of gas per 1,000 feet in Belfast varies somewhat in inverse proportion to the quantity used, but it may be taken at 3s. The maximum number of lights I can run direct from the engine is 8 of the 41 volts and 3 of the 82 volt lamps, equalling about 9½ brilliant lamps altogether; but as it is more economical where the power is limited to over-run the lamps for a given quantity of light, I get fully 20 C.P. from each 41 volt lamp. When first I started these lights I used a species of Planté battery, which I had picked up at an auction in Scotland; but it was useless either for storage or steadying the lights; but, indeed, by using a slack belt and a balanced fly-wheel in the dynamo, there was very little, if any fluctuation, in the lamps. However, I have now 24 cells of the E.P.S. Company, of the 11 S type, and, judging by my experience of them, they are everything I could wish for. The lights are absolutely steady, and under ordinary circumstances they are receiving a charge while some of the lights are used in the house. To accomplish this, I increased the E.M.F. of the machine to 56 volts (by running it faster). I then interposed some grades of resistance on the main leads between the lamps and the dynamo and battery; when the battery alone is employed, the additional resistance is cut out.

With reference to the relative *cost* of the electric light and gas for illuminating a house similar to mine, I find that if the interest on first cost is not reckoned, and if the attendance (in my case it costs nothing) is not added, the cost of the electric light is practically the same as a similar illumination by gas, but the advantages of the former are so immensely greater in other respects, that there is no comparison in the results.

J. H. Greenhill.

Belfast, *January 4th*, 1886.

The Brockie-Pell Arc Lamp.

My attention has just been drawn to a paragraph in your journal of 25th ult., criticising the test of the Brockie-Pell lamp as to its constancy of potential. It has been my experience of arc lamps, during the last six years, that a variation of only 3·3 per cent. is rarely met with, and I consider it a remarkable performance of an arc lamp to keep its potential so steady during a long run. I am sorry, however, that a grave clerical error had crept into the report of the test, as the variation was really only *two* divisions in 300, and not ten, as stated, but I still maintain that, even although the variation had been 3·3 per cent., your criticism upon this performance was hardly warranted.

I shall be glad if you will give this letter prominence in your next issue.

James Brockie.

14, Union Court, E.C.,
January 6th, 1886.

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
Vol. XVIII.—No. 425.

OVERHEAD WIRES.

The damage caused to overhead wires by the recent snow storm has produced in the daily papers the usual crop of correspondence on the subject. It is at first sight somewhat difficult to see why the wires should be the subject of attack whilst other dangers have been taken no notice of; possibly, however, the reason may be that the one is very directly noticeable. The writers, it may have been noticed, lay particular stress on the "danger" question. Now if the recent damage which has taken place has brought out one fact more plainly than another it is that the actual danger is absurdly exaggerated. The cases in which damage has been done to individuals by the falling wires are insignificant. Of course, that serious injury *might* have been done, as it *might* have been done from a hundred other causes, is undeniable, but in the face of actual facts the logic of this argument loses most of its force. We do not ourselves consider that overhead wires are by any means to be advocated as desirable appendages to housetops; they are decidedly unsightly and are sources of great *inconvenience* in cases of breakage, for the interruption of telephonic or telegraphic communication is very objectionable and the avoidance of it is a thing much to be desired. The failure of fire alarms, too, is a serious matter, as has recently proved to be the case. Here, it is true, we have a real source of danger, though not of the kind of which so much is written. Generally speaking, the whole matter is one of expense. In the case of fire alarm circuits this latter point should not, we think, be for a moment considered; the major portion of the mileage of such circuits is at present underground, and no time ought to be lost in making it wholly so; in any case, the expense which this would involve could not be extreme. As regards telephone wires, the question of expense would be a most serious one for the companies themselves. The working difficulties need not be considered, as telephonic communication can be carried on without difficulty through a far greater length of underground wire than any of the London renters at present require to work through; thoroughly good speaking has been carried on through an ordinary double underground line of a total length of 80 miles, the speech being so good that there was no doubt but that this distance could have been exceeded. To place all the telephone wires underground, however, would involve such an increase in the capital of the companies as would cause a heavy reduction in the dividends, for no increase in the present renter's rates could be ventured upon. The moral drawn by the correspondents to whom we have alluded is "No more overhead wires." When the Tay Bridge failed, was the moral "No more bridges?" Was it not rather "No more badly-constructed bridges." Let the overhead telegraph or telephone systems of wires be more strongly built and then the very slight accidents which we hear of would be reduced to insignificance and inconvenience reduced to a minimum.

A NEW SOUNDER WITH BI-RESISTANCE COILS.

A new and ingenious sounder has been introduced by Messrs. E. S. Greely & Co., successors to L. G. Tillotson & Co., of New York.

The sounder is designed principally to save the battery, which, with the usual form of sounder, is closed on low resistance. To effect this, states the New York *Electrical World*, the "economic" sounder contains two sets of resistance, and is so constructed that there is only the usual amount of resistance in its coils (about 3 ohms) when the circuit is open, so that it responds to the closing of the circuit with all the activity of the ordinary sounder. But as soon as the armature lever strikes the anvil, it throws 100 ohms resistance into the circuit, thus preventing the rapid absorption of the battery power incident to short circuit. As soon as the circuit is opened again, and the armature released, the sounder returns again automatically to the local basis with all the rapidity and smoothness of an unchanged resistance.

Computation from actual tests over an extended period of time shows that the average saving of battery power in large offices where the sounder is kept in most active use is very large, and in railroad offices, and especially in country commercial offices where the sounder is idle for a large part of the day, the saving is still greater. It robs nothing from the power of the instrument when the magnets are exerting their force to attract the sounder, but when that work is accomplished, it immediately throws into circuit its 100 ohms resistance as a guard against extravagant waste, and no matter how rapidly the work is carried on, it cannot be too quick for this ever-present and infallible guard that confines the outlay of strength to the limit of necessity, which has been demonstrated to be, in even the most active work, less than 25 per cent. of the whole power usually expended.

So far from its use exciting any prejudice in Morse practice, it has been remarked by operators after having had the instrument in use for some time, that the "economic" sounder gives forth a peculiarly soft, agreeable tone, with an entire absence of the racking thud of the ordinary sounder that shocks the oral tympanum, and renders a recurrence to its voice seem notably harsh and hard to a sensitive ear. There is a marked difference in tone between that of the up stroke and the down stroke, facilitating in a surprising manner the work of the ear in translating the sound, so that the rapidity of the same writing, by clearer partition of the signals, is made to seem much reduced.

Owing to the fact that under the principles of construction upon which the "economic" sounder is based, the cores of the magnets begin to demagnetise as soon as the armature strikes the anvil, and continue in the operation of demagnetisation up to a certain limit, the tendency to stick is reduced, it is safe to say, over 75 per cent.; and for the same reason the armature is more ready to answer to the tension spring upon the opening of the circuit, thus creating additional conditions favourable to clearer annunciation in rapid sending.

Electric Lighting in Mills.—Messrs. Gent & Co., of Leicester, have just completed an installation in the mill of Messrs. Rust & Co., the well-known spinners.

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THE DAFT ELECTRIC MOTOR IN BALTIMORE.

MR. ROBERT L. HARRIS has lately given an account, at a meeting of the American Society of Civil Engineers, of the working at Baltimore of the Daft electric motor, now being tested on the Ninth Avenue line of the New York Elevated railroad.

The Baltimore and Hampden Railroad is a suburban line of about two miles in length; gauge, 5 feet 4½ inches. It was heretofore an old horse railroad, and is a feeder to a main line of the Baltimore horse railroads. It is now operated by the Daft motors. This road has iron rails, 25 pounds per yard, laid on cross-ties in a cheap manner, and runs along the side of suburban streets or roads. The country is undulating and the route is crooked. Its curves are from 40 feet to 90 feet radius, and the grades are from level to the rate of 330 feet per mile. The superintendent, Mr. T. C. Robbins, says there are only about 300 feet of continuous level on the route, and very little level on its entire distance. A 25 pound steel rail has been placed on insulators near the middle of the ties as a conductor, and was roughly guarded by joists and planks laid on each side of it. The reason for using 25 pound rails as conductors was simply that in case of failure they would be useful for repairs. It was unnecessarily large for a conductor. Electricity has been used upon the road in place of horses since September 1st, 1885. The sections of conducting rail, as also of the track rails, are electrically connected by wires. In some places these wires are not insulated, and the rails were connected by a mere loop of ⅛ inch copper wire. The connections at main dynamo are of ⅜ inch copper wire insulated. At the engine-house there is a boiler, two doors to the fire-box, 14 feet long, 5 feet diameter, with 60 3½-inch flues. The engine is 16 by 24 inch cylinder, which, with 30 pounds of steam at 110 revolutions per minute, is said to develop about 75 horse-power. This engine drives two nominal 50 horse-power Daft dynamos, which supply the electric current to the rail. The engineer said that when both motors, each with a loaded car attached, were ascending the steepest hills, the full capacity of his engine was used, but when neither were on a hill not 10 horse-power was used. This engine uses about 1½ tons of coal per day of 18 hours, with fires banked at night. Two motors are in use, each weighing about 4,500 pounds and rated at 10 horse-power. A new motor, weighing about 5,000 pounds and rated at 20 horse-power, had just arrived, and was connected with the current and moved about. The motion of the armatures was stated as about 1,200 revolutions per minute; they were geared to the driving axle of the motor by ordinary tooth geared wheels in the proportion of 12 to 1, and the speed of the motor arranged for 12 miles an hour. But one strength of current has thus far been used, of low intensity; there has been no occasion for other powers of current. No electric brake is being used.

We rode, said Mr. Harris, on a regular trip to the end of the road and back with a street car attached, such as is ordinarily used with two horses. The average load was about 18 passengers. We went around one curve of 40 feet radius on a grade of 275 feet per mile, and around a curve of 70 feet radius on a grade of 330 feet per mile. While we were ascending a grade of about 320 feet per mile, the other motor was said to be at the same time ascending a similar grade. We stopped near the middle of this grade and started from full stop without difficulty. The toothed gearing made some noise, but passing horses did not seem frightened. It is expected to avoid toothed gearing by friction gear. The motors are controlled by one man, and, with car attached, start from each terminus about once an hour, and pass each other by side track. Mr. Robbins told me that the Morse has run 1,006 miles with no repairs (except oiling). Its average duty is 75 miles per day. No especial skill is needed; he had at times run his motors with men taken right off the road. He is satisfied with this power, and hopes that his company will soon use it on the other 6 miles of suburban road which they own. His company owns also 14 miles of Baltimore city horse railroads. He considers that his present power would run on his road five motors, each carrying one car, and, were there but 150 foot grades on his road, his present power would run five motors with three cars each. As now run the two motors take the place of 30 horses and are as cheap, and were he running eight cars there would be a saving of one-half the cost of horses for the same duty. There has been no trouble in heavy rain and thunder storms; he thinks it works better in wet weather, and has even known the flange of the conducting rail to be in water for a short distance during a rain storm. He says two of the men that have run the motors were locomotive engineers, and their expression was, "It lays away over steam." In fact, he thinks steam would not, with such light engines, carry such loads up such grades as has been done by the motors. Mr. Robbins states that he had had no troubles other than mechanical, which are now remedied (the armatures and brushes were at first too light).

As a test for himself, Mr. Robbins once sent to the city for one of their heaviest cars...lbs.	5,100
And carried a load of 81 persons over the road (say 81 by 125 pounds) ... ...lbs.	10,125
The weight of the motor used was ... ...lbs.	4,500
Total ... ...lbs.	19,725
Thus, he says, that 19,725 pounds were carried over the road by one motor of ... ...lbs.	4,500

His engine and boiler cost, approximately...	$2,400
His two motors cost, approximately, $3,000 each	6,000
Total	$8,400

There is also the expense of conducting rails and wires, insulation, protection, &c.

His expense of running per day is 1½ tons of soft coal	$4.75
Engineer and fireman at power station ...	4.50
Or, excepting oil, waste, wear and tear, per day	$9.25

The above represents the cost of his power, and equals the work of 30 horses per day. The average receipts from the cars carried by the two motors are $18 per day, and he has taken (on a Sunday) total receipts of $86 in one day.

THE PRACTICAL GAUGING OF VOLTMETERS.

IT is known that measuring apparatus very rarely give concordant indications, says M. G. Rouy, in *L'Electricien*. This depends on initial errors in gauging, on the weakening of the magnets, and on molecular changes in the springs or on other causes. Hence follows the necessity for frequently regauging measuring apparatus.

We shall concern ourselves here merely with the gauging of voltmeters, that of amperemeters having been already considered (*L'Electricien*, August 8th, 1885, No. 181, p. 529). The following is a method easily carried out with the same apparatus as those necessary for gauging amperemeters.

Let us suppose that the apparatus in question is a voltmeter intended for measuring differences of potential not exceeding 20 volts, a convenient range sufficient for amateurs who wish to know the difference of potential at the extremities of their batteries or of the lamps of a private lighting installation. We arrange in circuit the standard, the resistance box and the galvanometer with its shunt. Let us take, *e.g.*, as standard, a Daniell element, where the zinc is immersed

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in a solution of sulphate of zinc, half saturated. The electromotive force of such an element is 1·07 legal volt, and a Deprez-d'Arsonval galvanometer with a movable coil having, for instance, a resistance of 150 ohms. We regulate the resistance of the box and that of the shunt so as to give the galvanometer 100 divisions per volt. Let the resistance of the box be 1,000 ohms, and that of the shunt 10. With 20 volts we should therefore have 2,000 divisions, but if we render the total resistance of the circuit 10 times greater by putting 10,090 ohms in the box we shall have 200 divisions to 20 volts, or 10 divisions per volt; we can then appreciate exactly the tenth of a volt. We arrange then in the circuit a battery, the electromotive force of which is at least = 20 volts, and a rheostat for varying the difference of the potential at the extremities of the battery. We then measure simultaneously this difference of potential with the voltmeter to be calibrated and with the graduated galvanometer, and verify thus the exactitude of each point of the graduation.

Let us suppose, now, that we wish to recalibrate a voltmeter of 60 volts like those used for measuring the difference of potential at the extremities of arc lamps. We regulate the Deprez-d'Arsonval galvanometer so as to give two divisions per volt; therefore, as before, we had 100 divisions per volt, we render its sensibility 50 times smaller by multiplying the resistance of the box by 50. We then arrange in series the elements of the battery (Daniell, Leclanché or accumulators) in such a number that the electromotive force may be at least equal to 60 volts; and by means of two loose wires we take the difference of potential at the extremities of 1, 2 . . . . n elements successively with the voltmeter and the galvanometer.

If in place of a voltmeter of 60 volts we have one of 110 volts, such as those used in the Edison system of distributing electric energy, we operate in a similar manner, acting on the resistance and the shunt of the galvanometer, so as to have only one division per volt.

We may easily obtain the potentials necessary for graduating these apparatus by means of Planté's battery; 20 small accumulators mounted on the same stand may be connected in series or in quantity by the aid of a commutator. They are charged in quantity and then connected in series, and by means of loose wires a variable number of them are arranged in circuit with the voltmeter and the graduated galvanometer.

THE ELECTRICAL TRANSMISSION OF POWER TO A DISTANCE.

In 1873 a well-known experiment, executed at the Vienna Exhibition by M. H. Fontaine, demonstrated the reversibility of the Gramme machine, writes M. Manceron in *Comptes Rendus*, and showed for the first time the principle of the transmission of power to a distance by means of electricity. This discovery has already received numerous applications: the interest with which the experiments made at Munich and Grenoble have been followed as well as those now in progress at Creil, show the importance which is attached to progress made in this direction.

The experiment of 1876 had a great success as a curiosity, but it was only in 1876 that the first practical utilisation of a principle now so fruitful was realised. This application was made in one of the establishments of the artillery at the workshop of precision at St. Thomas d'Aquin, placed under the orders of the President of the Committee of the Artillery.

This workshop which is specially arranged to establish standards of measurement and to make all the instruments of verification and control destined for the manifold uses of the artillery, possessed a very accurate automatic dividing machine, furnished by the firm Dumoulin Froment, and driven by means of a Froment electric motor and a battery. As the machine was in action only at irregular intervals, it was necessary whenever it was wanted for use, to fit up and take down the batteries, the maintenance of which involved great inconvenience. Captain Manceron, attached to this workshop, proposed to substitute for the battery an electric machine set in motion in the workshop itself, the current of which should actuate the Froment motor at a distance. M. Niaudet, of the firm of Breguet, with great kindness placed at the disposal of this office a small Gramme machine with a Jamin magnet. The attempt was quite successful and the batteries were finally laid aside.

Some time afterwards a circular dividing machine, worked by hand, was transformed and arranged like the former. A second motor thus becoming necessary, a dynamo-electric Gramme machine was purchased which was to serve also for other applications. The machine with the Jamin magnet was made the recipient instead of the generator.

The second of these two machines is mounted in an annexe connected with the workshop. The first, from which more precision is required, has been placed in a separate building in order to be as much as possible out of the reach of vibrations. The circuit is not more than 200 metres.

A rheostat by means of which the strength of the current can be modified, accompanies each motor and enables the speed to be regulated at will. The force to be transmitted is feeble; the work utilised is about one kilo; but the use of electricity has given in this case a convenient solution of a delicate problem.

This installation has not been modified since it was first put up. It was mentioned for the first time in an article by M. Niaudet, inserted in 1879 in the *Zeitsschrift für Angewandte Electricitäts Lehre*, published at Munich by Dr. Carl, Prof. of Physics at the Military Academy of that city. The author of the article, whilst asking for information on this subject, wrote on July 5th, 1879:

"These references have now a value which I will call historical. In a few years numberless and immense applications will be made: it is in my opinion of great importance to put it on record that the officers of the French artillery have anticipated the entire industrial world in this fruitful track."

Without raising here a question of priority, the Academy may permit us to declare once more in its presence that the Artillery is always attentive to effect progress when occasion permits.

MAGNETISM.

By WILLOUGHBY SMITH.

(*Continued from page* 34.)

It was thought that perhaps more accurate results would be obtained if the influence of the earth's polarised lines of force could be eliminated as regards the measuring magnet; therefore a glass tube 20 inches long and 2 inches internal diameter was fixed in a wooden base, B, diagram 6; C is a wooden cap fitted in the top of the tube. By means of a glass hook fixed in the centre of the cap was suspended, by a very fine silk fibre, the two small magnets marked, S N, N S, which were rigidly connected by a fine glass rod, R. The intensity of the magnetism in each was such that the couple was apparently unaffected by the earth's magnetism. A rod of charcoal iron, 10 inches by ·3 inches diameter, was annealed by being heated to redness in a forge fire, and there allowed to remain until the fire died out and the rod became comparatively cold; it was then supported horizontally on glass, and placed due north and south in such a position as to be in a direct line with the lowest magnet. Then by moving the astatic arrangement into different positions while the rod remained stationary, the directions assumed by the magnets indicated the direction of the magnetic

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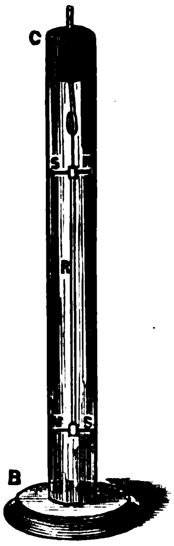
lines of force emanating from the iron rod. In experiments with this kind of measuring instrument great care must be taken not to place the magnets too far from the iron, because the low intensity of the magnetism induced in the iron by the earth's polarised

DIAGRAM 6.



lines of force is then insufficient to fully overcome the very slight torsion of the silk fibre, or the absence of absolute uniformity of magnetic tension in the small magnets. On the other hand, if the magnets be placed too close to the iron, it will be found that they induce magnetism into the iron, and, consequently, interfere with the results. It will, therefore, be understood why very careful adjustments are necessary before reliable data can be obtained. Figs. 1, 2 and 3, in diagram 7, show the results obtained with a rod, square plate, and a disc of iron. The arrows indicate the direction assumed by the magnet in each position in which it was placed relatively to the iron, which, in each case remained stationary. The results are very similar to those obtained by the single mirror reflecting magnet; and, as that arrangement was more easy of manipulation and accurate in measurement, it was again used for all similar experiments.

If permanent polarity, however slight, has been communicated to either iron or steel in any form by any known means, the intensity and direction of its polarised lines of force can be measured. A ring made from a steel rod ·375 inches diameter was hardened in oil and then mounted on a wooden disc, through the centre of which passed a small spindle, to allow of the ring being easily revolved vertically at right angles to the small suspended magnet, the distance between the two being 18 inches. No effect was observable on the magnet, although the ring was revolved several times. The outer surface of the ring was marked off into eight equal parts. One of these lines was marked S, and magnetism was then imparted to the ring as follows. The south pole of a powerful permanent steel bar magnet was placed on that part of the ring marked S, and the ring was then slowly revolved until its circumference had passed *once* under the south pole of the magnet, so that the point of first and last contact was at the line marked S. The bar magnet being removed, the ring was again very slowly revolved at the back of the suspended magnet, and under precisely the same conditions as before, and, when each line marked on the ring was directly opposite the centre of the magnet, the amount of the deflection of the magnet, as indicated by the reflection from the mirror, was noted. Diagram 8 shows the results obtained, H indicates the position of greatest effect, and L the position of no effect. It will be seen that the point of no effect is near to the line S, that being the place at which the magnetism commenced and ended; and that the point of maximum intensity is farther from S in the opposite direction.

DIAGRAM 7.

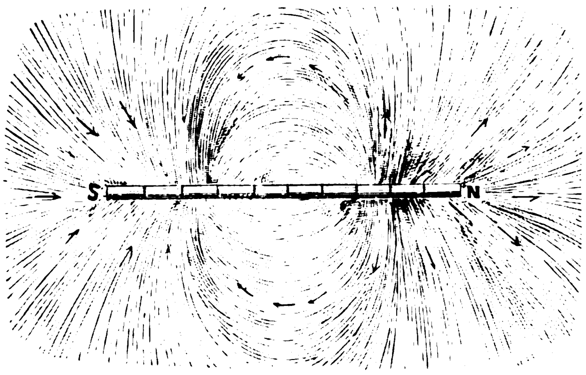


FIG. 1.

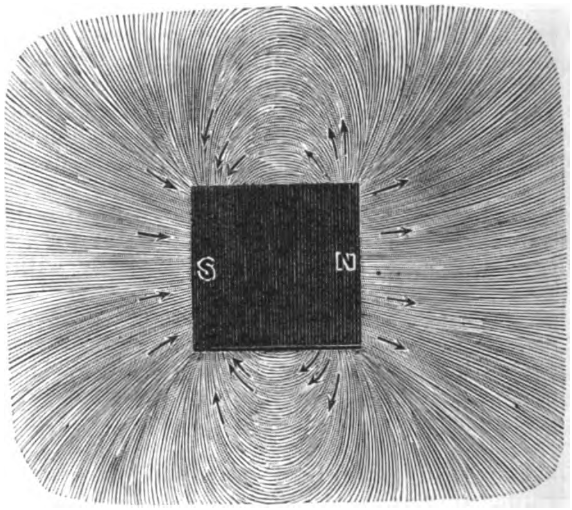


FIG. 2.

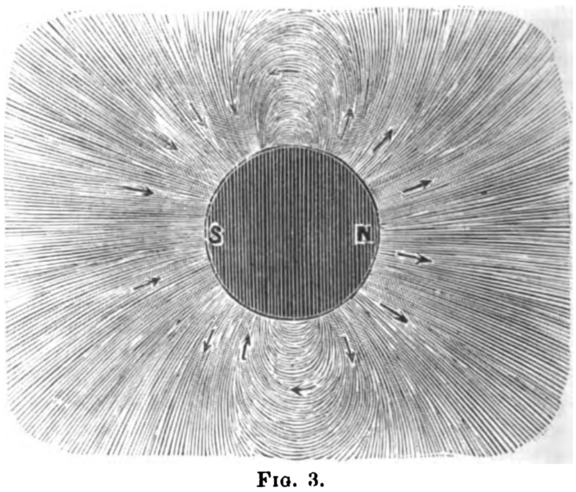
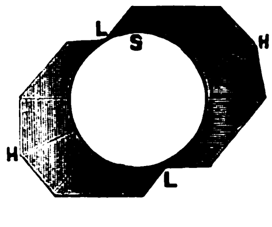


FIG. 3.

It was also observed in this experiment that after having passed the magnet once round the ring no

DIAGRAM 8.



greater magnetic intensity could be imparted to the ring no matter how many times the magnet was

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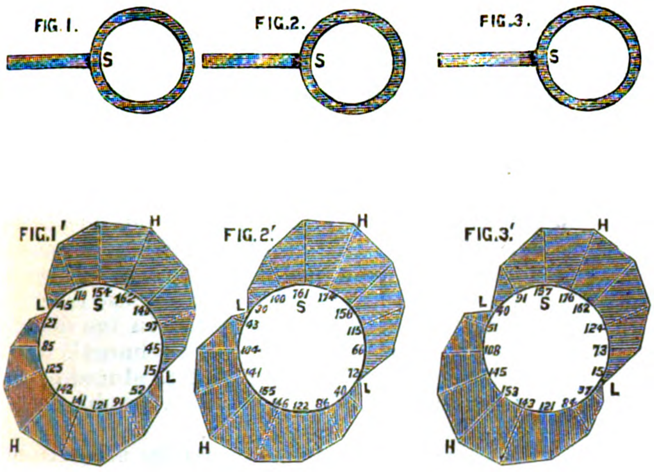
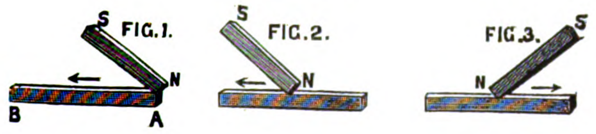
applied, providing it was each time applied over the same part of the surface. But if it were passed over another portion of the surface, then the magnetic intensity of the ring was slightly increased. To further investigate what to me was a new phenomenon, a square edged ring, 8·5 inches internal, 9·5 inches external diameter, and ·5 inch thick, was cut from a plate of best "Lowmoor" iron. The object was to avoid a welded joint, which it was thought might, in some way, have influenced the results obtained in the last experiment; and also, by having four sides to the ring, the surfaces could be each magnetised with greater precision than possible with the rounded sur-

DIAGRAM 9.



face of the first ring. This ring was manipulated and tested in precisely the same way as the previous one. When magnetised around its edge, as shown in fig. 1, diagram 9, the results were as given in fig. 1′ in the same diagram, the figures representing the deflections noted when that part of the ring was in a direct line with the centre of the small suspended magnet. Figs. 2 and 2′ show the results after the magnet had also been applied to the top side of the ring, and figs. 3 and 3′ after the magnet had been passed over its under side. Looking at the total of all the deflections of each test it will be seen that the increase of intensity is very small for the additional application of the magnet on either of its sides. These experiments were continued with a steel bar in the place of the ring, and it was found that if the bar were magnetised by drawing the magnet from end to end, as in fig. 1, diagram 10, then the maximum

DIAGRAM 10.



result is obtained by the first rub, unless a fresh surface of the bar passes under the magnet; but if the magnet be passed from the middle of the bar to one end, and the magnet being then reversed, it be passed from the same point of the centre of the bar to the other end, as in figs. 2 and 3, then the induced magnetism in the bar is increased by repeated applications of the magnet. In one experiment the following values were obtained:

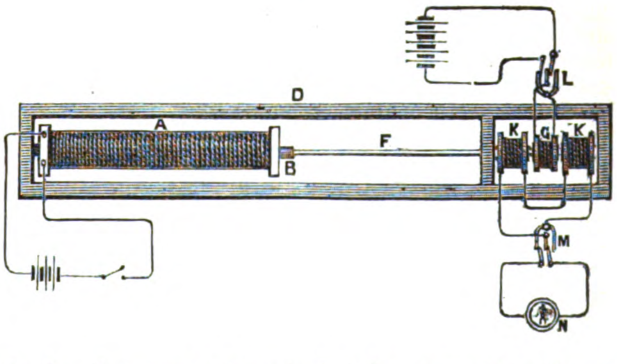
After one rub, deflection	...	...	137
„ five rubs, „	...	...	156
„ ten rubs, „	...	...	176
„ fifteen rubs, „	...	...	180

Although the magnetism induced into the bar is only increased by repeated application from 137 to 180, or thirty-one per cent. as measured by the energy of its polarised lines of force, yet its attractive power is nearly doubled, as the attraction between a magnet and its armature increases as the square of its "free magnetism." In drawing the magnet along the bar from end to end, as shown in fig. 1, it was observed that the ends of the bar were not of the same intensity, the end, B, where the magnet leaves the bar, being considerably stronger than the point, A, where the contact was first made.

It is just 100 years ago since it was first asserted that if an iron wire, not less than ten yards in length, were stretched in the open air, it would spontaneously give forth a sound when under the influence of a certain variation of the state of the atmosphere. On investigation, this was attributed to the effect of atmospheric electricity, and the correctness of that supposition was confirmed when it was demonstrated that the discharge from a Leyden jar through an iron wire produced the same phenomenon; but no further notice appears to have been taken of the subject until 1837, when attention was called to the fact that if a flat spiral through which a current of electricity is passing, be brought near the pole of a powerful magnet, a sound would be heard. In the following year it was made known that if a soft iron armature be revolved rapidly before the poles of a horse-shoe magnet, a sound is produced, and in 1843 it was noticed that plates or rods of iron, when placed in the interior of a helix, gave a very decided sound each time the helix was connected with, or disconnected from, a strong electrical battery; it being also, at the same time, asserted that a decided elongation of the iron rod occurred simultaneously with the sound. These phenomena were attributed to a change, produced by the magnetism, in the molecular constitution of the magnetised iron. The sound can be distinctly heard without external aid, but the supposed elongation of the rod requires very delicate appliances for measuring it, as under the most favourable conditions it is very minute. Prof. Joule, in one of his experiments, found that a bar of soft iron experienced "a decided elongation," which was about $\frac{1}{720000}$ of its total length, at the moment when the current by which it was magnetised was established, and a shortening at the moment when it was interrupted. These phenomena have frequently engaged the attention of experimenters, but no definite or satisfactory results have, as far as I am aware, been arrived at.

It has recently been experimentally demonstrated that a rod of iron only increases in length up to a certain point, and that if the strength of the exciting current passing through the helix be increased after the maximum length is reached contraction commences, and the bar apparently becomes shorter than its original length. In my research in this direction, great difficulty was, at first, experienced, from the want of a simple but, at the same time, efficient measuring apparatus; this was at last overcome by the construction and adoption of the apparatus as shown in diagram 11; this arrangement proved most valuable, not

DIAGRAM 11.



only for these experiments, but for measuring the expansion and contraction of metals under the effects of varying temperatures, and other similar experiments; in fact, as a gauge it can be made as accurate and sensitive as "Newton's scale of colours."

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A, is a helix of cotton covered wire (·083" diameter) wound in 10 layers of 198 turns each, the resistance of the entire length being 1·613 ohms. Inserted in the helix is the iron bar, B, 1·375 inches diameter and 27 inches in length; one end is rigidly fixed to the wooden frame, D, and the other end carries a glass rod, F, the further end of which passes freely through the hollow iron core of bobbin, H, and supports the centre bobbin of wire with hollow iron core, G. A fine screw adjustment permits this bobbin to have a movement of about half an inch along the glass rod, so that it can be placed in any desired position between the similar bobbins, H and K, which are rigidly fixed to the wooden frame, D. A rapidly alternating current can be sent through the wire on bobbin G by means of a reverser, L. The wire on bobbins H and K is so joined that the electromotive force induced therein from G exactly neutralises each when the bobbin, G, is placed midway between them, but under these conditions the slightest movement of G is sufficient to destroy this neutrality. In circuit with the wire on H and K is a reverser, M, which causes the induced current to pass in one direction through the mirror reflecting galvanometer, N. The glass rod was of sufficient length to allow H to be 31 inches from the iron rod, B, and at that distance no direct inductive effect from B apparently affected H. Having established the point of no current by shifting G until its neutral position was found, which was exactly midway between coils H and K, then, by means of the fine screw, G was moved $\frac{1}{3000}$ part of an inch from its central position towards K. This slight movement was sufficient to produce a deflection of 44·1 divisions on the galvanometer scale. Having obtained this "constant," the values given in Table II. were obtained. It will be seen on referring to the table that the apparent elongation of the rod has reached its maximum when a current of four ampères is flowing in the helix, and, as the current increases, an apparent contraction of the bar takes place until, with a current of 16 ampères, the rod appears to be of the same length as at the commencement of the experiment, and as the current is further increased, the length appears to diminish, and with 21·5 ampères it appears to be

TABLE II.

Coefficient of Instrument:—
44·1 divisions on Galvanometer scale = ·000333 of an inch.

Ampères flowing in magnetising helix.	Deflection on galvanometer.	Apparent increase in length.
1	1	·0000076 in.
2	4	·0000302 „
3	8·5	·0000642 „
4	9	·0000680 „
5	9	·0000680 „
6	8·5	·0000642 „
7	7·5	·0000567 „
8	7	·0000529 „
9	6	·0000453 „
10	5	·0000378 „
12	3·5	·0000264 „
14	1	·0000076 „
16	0	———
18	− 2	− ·0000151 „
20	− 3·5	− ·0000264 „
21·5	− 6	− ·0000453 „

·0000453 of an inch less than its original length. I have said *apparent* elongation and contraction of the rod, and I have intentionally done so, for it is my belief that neither elongation or contraction takes place. I have already stated that if a helix of insulated copper wire be placed horizontally, and one end of a rod of soft iron be presented at one end of the helix, it will be attracted into the helix on the first impulse of the current, and place itself so that its centre coincides with that of the helix. And also that a helix of insulated wire, enclosing an iron core, not only causes the iron to become and continue a magnet by induction so long as a current is flowing through the helix, but that the helix itself becomes a magnet, and possesses a sphere of magnetic lines of force quite independent of similar lines given out by the iron. This being so, it appears to me that, as soon as the current is passed into the helix, the lines of force from the rod endeavour to place themselves symmetrically with those given out by the helix, and thus, I think, is caused the slight movement of the whole rod, and not an elongation of it as supposed. When the rod becomes saturated, the intensity of its lines of force remain constant; but not so with those from the helix, as they continue to increase in intensity in proportion with the increase of the tension of the current passing through the circuit, and thus, I think, affect the lines of force of the rod, causing the latter to move in the opposite direction, which movement is mistaken for contraction. Just as I have shown the small magnet is moved by its lines of force adjusting themselves so as to be symmetrical with the lines proceeding from the iron rod or disc, so, I believe, is the iron rod moved by its lines of force adjusting themselves to those of the helix, and, I further believe, that the sound usually heard on making or breaking the current in an experiment of this kind is not due, as is supposed, to any effect in the iron itself, but is caused by the lines of force adjusting themselves to each other; for, as is well known, the more intense the current the louder the sound, as instanced in the sounds given off by what is termed the "discharge" from powerful electrical machines, or that produced by an electrical phenomenon of nature which produces the sound called thunder.

Although far from having exhausted the subject—in fact, it appears to me inexhaustible—I feel that sufficient, if not more than sufficient, has been written to accomplish the purpose with which this pamphlet was commenced. I will therefore conclude by remarking that, what I have written being intended for instruction and not display, I have avoided all those phrases and technicalities which are so apt to puzzle and mislead, and have endeavoured to express my meaning in plain and simple words.

ON THE EFFECTS OF THE "QUANTITY" RHEOSTATIC MACHINE.

FIG. 1 represents the latest arrangement which I (M. Gaston Planté, in *Comptes Rendus*) have adopted for the "quantity" rheostatic machine. Whilst in the "tension" rheostatic machine the mica-plate condensers are successively associated in quantity during the charge and combined in series during the discharge, in the present apparatus the condensers remain combined in quantity during both the charge and the discharge. Being separated by thin plates of ebonite they form a vertical battery arranged below a commutator, which can be thrown into a rapid movement of rotation, and which connects alternately these connectors either with the branches of a discharging rod, or with any other apparatus destined to be traversed by discharges.

I have already enumerated some of the special phenomena produced by the current *sui generis* which results from this continuous series of discharges of condensers re-charged incessantly with great rapidity by a source of voltaic electricity of high tension. But among the most remarkable effects I will mention what I have observed under the following conditions:—

If we cause the current derived from this apparatus to issue at the surface of a conductive liquid, such as salt water, by a wire introduced into a portion of capillary tube of 0·03 metre in length, and terminating at 0·002 or 0·003 metre from the extremity of the tube plunged into the liquid, so as thus to confine in a narrow space the quantity of matter submitted to the direct action of the current, there is produced a real

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fountain formed of extremely fine drops, which rise to more than 1 metre in height (fig. 2).

The passage of the sparks into the liquid by the immersed tube is accompained by violent shocks and by a very intense noise; the mechanical force which comes into play in this narrow space is so considerable that it sometimes breaks the glass basin in which the experiment is conducted.

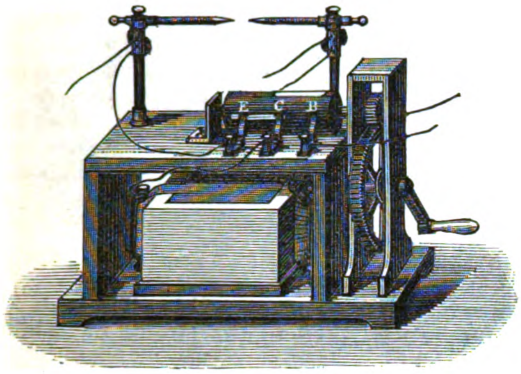


FIG. 1.

If the pole which enters into the tube is positive, the other electrode being entirely plunged into the liquid, the fountain is also produced, but it does not reach as great a height as when this pole is negative.

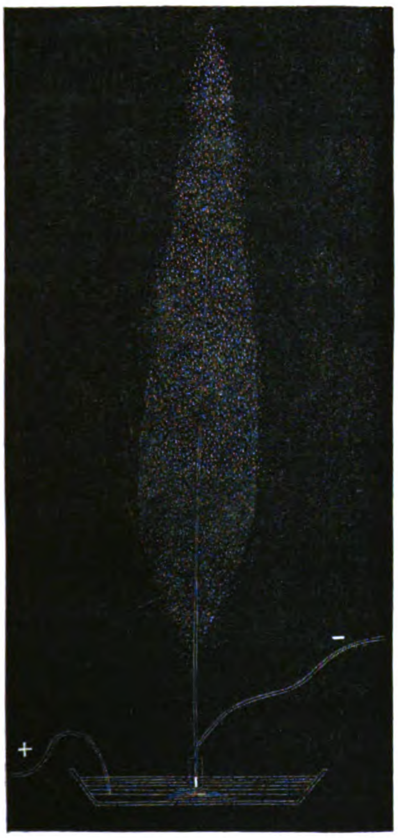


FIG. 2

When the electrode simply touches the surface of the liquid, without its extremity being enclosed in a glass tube, which partially insulates it, the liquid is only projected to the height of half a metre but it forms a sheaf of larger drops, and the vessel in which the experiment is performed is soon almost entirely emptied in consequence of the scattering of the liquid.

If the arrangement of the apparatus is reversed so that the extremity of the capillary tube near which the wire terminates is turned upwards instead of plunging into the liquid, and is kept merely moistened by the salt water, whilst the other electrode touches the upper portion of the tube, the spark produced, and continually renewed, takes the form of an irregular flame accompanied by a loud crackling, due at once to the mechanical pulverisation of the water, to the detonation of the gases derived from its decomposition and to the combustion of the sodium set at liberty.

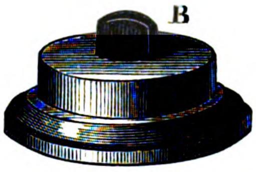
The experiment represented (fig. 2) imitates in a striking manner the effect of the extraordinary stroke of lightning at Ribnitz, which we have already mentioned (*Comptes Rendus*, C., p. 1388, and *Zeitschrift für Elektrotechnik*, May 14th, 1885), during which a jet of water rising from a soil drenched with rain followed the very track of the flash and entered a house through a hole which the lightning had pierced in the glass of a window.

These experiments explain, also, how, when a waterspout strongly charged with electricity so as to manifest luminous effects or globes of fire at its extremity reaches the surface of the sea, it produces all around it a large sheaf of pulverised water, and sometimes an ascent of water along the cloudy mass, or even in the interior of the vaporous channel of the spout.

SOME SWITCHES FOR ELECTRIC LIGHT INSTALLATIONS.

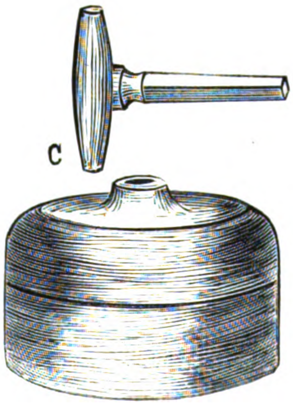
MESSRS. Woodhouse and Rawson have just brought out a set of switches of different types suitable to the varying circumstances of electric light installations. These we illustrate and describe under:

B is a small switch of neat appearance, in which a tongue of metal, fixed to a centre pin and handle, makes good rubbing contact between two metal plates, the connection being continued through a safety fuse



if required. A sharp, quick break is given by a spring, which also prevents inefficient contact being made. This switch is made in two qualities and two sizes to carry respectively 3 and 10 ampères, and is turned out in various kinds of wood and different pattern covers.

C. This switch is somewhat similar to the B type, but connection between the two double contact plates at opposite diameters of the switch is made by cross



arm fitted with a square hole socket to receive a removable "railway key" handle, which can be made permanent if required. It is constructed in two sizes to carry respectively 30 and 60 ampères, and the base of the cover may be made in any fancy wood.

F. This switch has a movable arm, consisting of a number of thin brass plates, rubbing upon a set of

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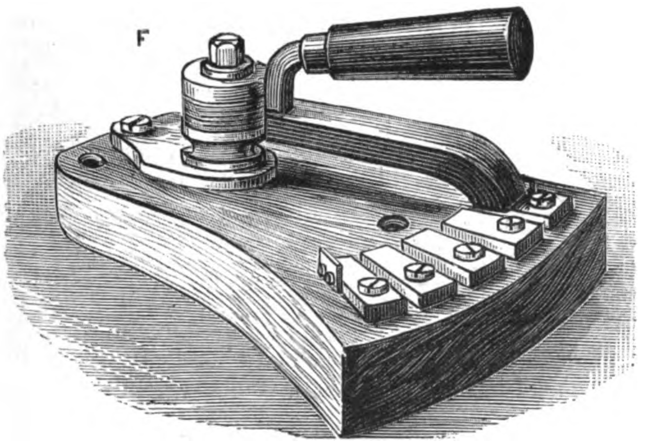
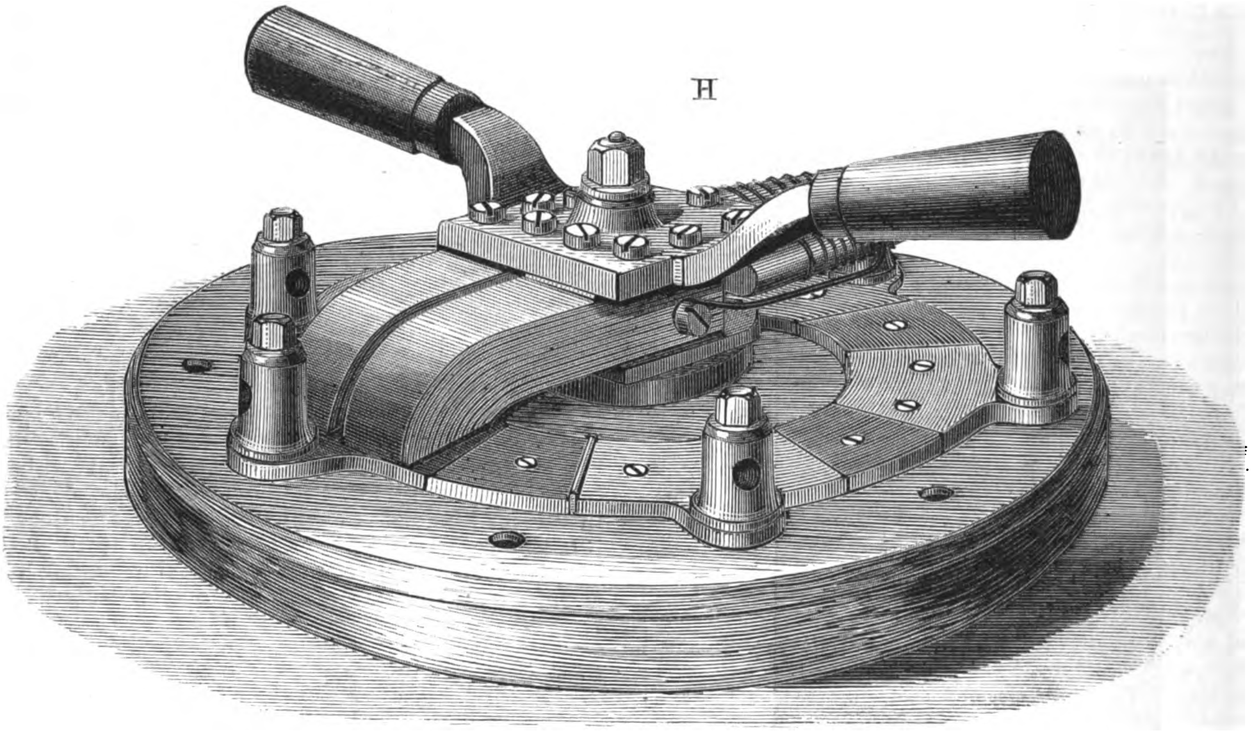
contact plates, and so making connection between the main terminals of the switch, which is attached to the centre fitting and any one of the contact plates. The


F

brass plates forming the movable contact arm are joined together only at the centre fitting, so that they form independent springs pressing edgewise on the

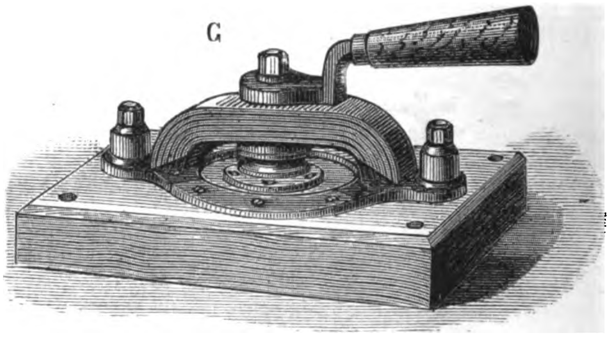

H

contact plates and thus ensuring an excellent contact. The sizes made will carry 30, 60 and 100 ampères respectively. The switch is particularly useful where it is necessary to pass from one source through any one of a number of circuits, or through different parts or continuations of the same circuit; it is therefore very suitable for switching in or out resistances when these are required to be variable in the working of dynamos, &c., or cells of a secondary battery when a cheap switch is required.

G. This is an exceedingly strong and well-made switch and particularly suitable for heavy currents. It has a brass plate contact arm as in F switch, with the exception that the arm bridges two contact plates at opposite diameters of the switch.

The switch may be 1, 2, or 3, and the sizes made will carry respectively 60, 100, 200 and 500 ampères.

H. The switch ordinarily used for regulating the number of accumulators in a circuit consists simply of a set of contact blocks over which a contact arm moves as in switch F; but in using this switch the cells between any two contiguous contact blocks are short circuited every time the arm passes from one to the other. The H switch is designed to prevent this short circuiting, which very much injures the accumulator


G

plates, and to prevent "sparking" which it does when properly adapted to the circuit on which it is used.

It has two contact arms or brushes, similar in construction to those of the F switch, rubbing over a number of contact plates connected to the cells; these arms are electrically connected to each other by a resistance coil, and are so arranged that one of them completely leaves one contact plate before touching the rest. When it does touch, the cell or cells between the two plates only are short circuited through the resistance until the switching motion is completed and the contact plate directly connected to the circuit. This is the only switch which gives these results without interrupting the main circuit; it is, of course, applicable in the case of primary as well as secondary batteries, and its use will very largely increase the "life" of accumulators and battery plates besides preventing the enormous waste of energy continually going on in the short-circuiting process.

Z. In nearly all installations it is necessary to subdivide the main current from the generating apparatus into several main sections, and this switch is specially designed with a view to this requirement. It consists of a guide plate connected to the main terminal of the switch through which slides an accurately-fitting metal bar, having at one end a convenient handle and

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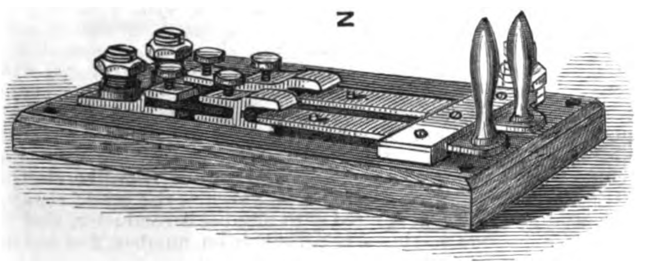
at the other a V-shaped spring contact which enters, and makes connection with, a brass jaw, this jaw having a fitting for a safety fuse through which the connection is continued to the branch line terminal. The number of slide bars with their jaws may be as large as is desired, all the bars being parallel to each



other and passing through the one guide plate, which is extended to the necessary length. By this arrangement any number of branch lines may be independently controlled and each has a separate safety fuse, while the construction of the switch allows the regulation of a number of circuits in a very small space.

SOME ELECTRICAL WORK IN 1885.

THE work carried out by the Anglo-American Brush Corporation during the past year comprises much that is of great importance as bearing upon the application of electricity in various industries in the future. The thorough manner in which its installations have been designed and carried out has also contributed in no small degree to the revival of confidence in electric lighting which is now beginning to be felt by the public.

Much has been done during the past twelve months towards perfecting the various kinds of electrical apparatus manufactured by the Corporation, who hold the unique position of being the only firm in this country supplying both high and low tension dynamos and arc and incandescent lamps manufactured by themselves. The exceptional facilities thus offered to improvement in combinations of plant used in every branch of electrical engineering have been thoroughly utilised by the company.

The high reputation which the Victoria dynamo has earned ever since its practical introduction has, during the past year, been fully maintained. This machine has been extensively employed by the Home and Foreign Governments for both naval and military purposes, and it is now a well recognised article of commerce. The various other accessories to electric lighting such as projectors, signalling and torpedo search apparatus have obtained wide celebrity.

The introduction of slow speeds for both engines and dynamos, for which the facilities offered in this direction by the construction and form of the Victoria dynamo has been in a great measure responsible, has resulted in reliability of working on board ship—which is being recognised throughout the mercantile marine—and has imparted an additional impetus to the electric lighting of passenger steamers.

Considerable attention has also been paid by the above company to motor work, and motors of large powers have been supplied both at home and abroad to work in conjunction with Brush machines of high tension to transmit power over long distances.

The Brush dynamo and arc lamp, in which important modifications have been made, still continue to hold their own. It is hoped that ere long a practical and extended application of their use may be seen in the metropolis on a scale somewhat like that adopted across the Atlantic.

Foreign contracts have constituted no inconsiderable portion of the Brush Company's operations during the past year; but among firms to whom, or localities where plant has been supplied or installations successfully carried out in this country may be mentioned the following:—The Central Station at Glasgow and the Grangemouth Station and Docks for the Caledonian Railway Company; the Waverley Station at Edinburgh; South Kensington Museum throughout with the new Brush-Sellon lamps; Holloway Sanatorium at Virginia Water; the Woking Convalescent Home; Messrs. Ritchie & Co.'s Mills, Stroud; the Duke of Bedford's yacht, *Northumbria;* the yacht *Christine;* the Newbattle Colliery and others. Many similar contracts are in hand for the coming year, amongst others the lighting of a portion of the Colonial and Indian Exhibition.

The past year has not been an uneventful one for the Corporation. Besides the consummation of important policies, initiated with the view of extending the scope of the company's business and influence, it is hoped, from the extensive and successful work carried out, that during the past year the company has in a commercial sense turned the corner.

The past year has also witnessed many important changes in the composition of the board of directors. In the early spring the company lost, by the death of Mr. Ladd, the services of one of its original directors and the co-operation of one of the earliest workers in practical electric lighting. As a result of the amalgamation with the Great Western Electric Light Company, the Corporation secured the services of Mr. Braithwaite as a director, and later in the year Lord Sudeley and Major-General Webber, C.B., accepted seats at the board, the latter doing so in the capacity of managing director.

Messrs. Cox-Walker & Co., of Darlington, inform us that their work during the past year consisted largely of the manufacture, supply and erection of their electric watchman's tell-tale; their systems of fire alarms, telephonic apparatus, in connection chiefly with "acoustic" and "mechanical" telephones; Vyle's patent "easily-tested" lightning conductors; household bells and electric sundries. With respect to the tell-tales, they continue to give satisfaction, and the demand for them arises almost entirely from the private recommendation of those who have used them. Notable among other large establishments the firm have fitted the immense premises of Messrs. J. and J. Colman, at Norwich. The recording apparatus was placed in the central fire station, under the charge of the active and intelligent superintendent of the Fire Brigade connected with the works, Mr. G. Durndell, and night and day the apparatus is at work recording the perambulations of the policemen whose duty it is to constantly patrol the extensive premises. By means of wires, contact boxes and keys, the movements of the police are recorded every quarter of an hour from about 28 different stations. The system admits of any number of stations being placed on one line circuit or of a separate circuit for each station, and both methods may be and are worked at the same time or on the same recording barrel, which is also self-starting at any fixed time. The firm's fire alarms, automatic and otherwise, have been adopted in several large institutions and give every satisfaction. With regard to mechanical telephones, the firm claims to have a large experience, and expresses surprise at the results obtained from one of the "Byng" acoustic instruments in combination with the neat and ingenious little pulley line guides or insulators sent out with them. The firm anticipates an increasing demand for these instruments as their utility and practicability become better known and more appreciated; they are put forward as filling the gap between the electric telephone and the speaking tube. Messrs. Cox-Walker & Co. exhibited a large variety of their specialities at the Inventions Exhibition, and were fortunate in obtaining the only silver medal granted for any similar exhibit. At the end of October Mr. Harrison retired from the business, which is now being carried on by Mr. Cox-Walker and his sons, and the present year has opened with gratifying prospects for improved business in the centre of the iron industry.

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SOME CONSIDERATIONS REGARDING INDUCTION.

By DAVID BROOKS.

ALTHOUGH Henry made known the existence of induction before the magnetic telegraph was brought into use, it was generally considered by practical men to be a myth, so far as concerned the operation of the telegraph. Varley and Stearns found it an obstacle to the successful working of duplex apparatus, and counteracted its effects by means of electro-magnetic coils and condensers. Edison was afterwards compelled to grapple with it in perfecting some of his telegraphic inventions. In the year 1868 the Prussian and French governments put up a couple of international wires between Berlin and Paris to be worked by the Hughes apparatus, and it was found that when the currents were intermitted upon one of the conductors a disturbance was produced upon the other. All of the leading electricians in France held a consultation for the consideration of the phenomena, and it appears by the records that they were about equally divided as to whether it was the effect of induction, or of actual lateral conduction. Extracts from the French journals found their way into American prints, a case in point being the *Journal of the Telegraph*, edited at that time by Mr. James D. Reid. M. Abel Guyot, secretary of the Commission d'perfectionment, communicated with me in reference to the phenomena, and as the disturbances took place in clear weather they were finally decided to be the results of induction. The discussion was participated in by Professor Hughes, Guyot, Blavier, Gavarret, du Moncel and others. While this interesting controversy was progressing similar demonstrations were observed upon the two wires put up along the Union Pacific and Central Pacific railways, between Omaha and San Francisco, and when the atmosphere was very clear and cold, producing a high state of insulation, it was found impossible to work more than one wire. These disturbances occurred only during clear cold weather. For months repairmen might have been seen on the rear of every train hunting for crosses which they never found in the form of actual contacts. The trouble, recurred, however, with the appearance of the first favourable weather. Mr. F. L. Vandenburgh and General Stager communicated with the writer in reference to the matter, and being familiar with like results under similar circumstances between Berlin and Paris, I came to the conclusion that the troubles were caused by induction. The entire subject, so far as the Western Union Telegraph Company was concerned, was referred to headquarters at New York, where it was decided that the whole difficulty arose from defective ground connections, the iron railway tracks being used for that purpose. In accordance with this theory some very large copper plates were shipped to Omaha and Salt Lake City to be used for earth connections in place of the railway track. Of course, the substitution of the ground plates failed to remedy the difficulty.

Induction can only be produced, or at least developed to its greatest extent, by very high insulation, whether upon parallel conductors, or in what are known as induction coils.

Noad states that " M. Ruhmkorff brought the induction coil to far greater perfection than it had hitherto attained by paying the greatest attention to the insulation of the secondary wire."

Some years since the writer secured a patent for saturating the bobbin of an ordinary electro-medical machine with insulating material, thereby increasing the effect produced upon the secondary wire to such an extent that it was as much as an ordinary person could endure without drawing out the plunger. The bobbin was immersed for 24 hours in melted paraffine at a temperature of 300° F., which expelled all the air and moisture from the cotton covering of the wire. I exhibited this improvement experimentally as applied to machines from different makers, but as their coils produced all the effect desired, by withdrawing the plunger, they could see no advantage in the increased effect produced, and consequently the patent has lain dormant. A coil so treated, however, is capable of being made in a much more compact form and with less length of wire. When currents are rapidly intermitted upon a telegraph conductor, a neighbouring parallel wire becomes charged in the same manner as the secondary wire in the induction coil. During the Centennial Exhibition, I laid a short cable from the outside of the grounds to the Department of Public Comfort. One of the conductors in this cable was used for the Edison automatic system, in connection with a wire to New York, and as many as 1,000 words per minute were transmitted through it. The very rapid intermissions of the current charged the other conductors of the cable to such an extent that they gave out a violent shock upon being touched, and these effects were produced at either end of the open wire, but had the two ends of the wire been brought together the discharge would have been double the intensity. In the central portion of the secondary wire there is a point where the tension is at zero. Mr. Preece shows this by the following diagram: *

One would suppose that if the insulation at points, *c*, *d*, was lowered the inductive effect would be increased, but it is not for the reason that the induced current goes to the insulator itself in proportion to its becoming a conductor, or losing its insulation, and consequently is not shown upon the parallel wire. The same effect is produced at the ends, A and B; therefore, inductive disturbances to be developed in a high degree require high insulation. It is influenced largely by other considerations and circumstances. There should be no other conductors in the neighbourhood, as may be demonstrated by the following experiment:

Let it be supposed that in the following diagram (fig. 2), an astatic galvanometer be attached to conductor No. 2 in a 50-wire cable 500 feet long. The galvanometer with its conductor being simply attached to earth, we charge number 1 with a battery of 100 cells.

In an actual experiment as we charged number 1 the galvanometer on number 2 produced a deflection of 130 divisions. It makes no difference upon which end of the conductor we place the galvanometer, the effect is the same, and the current going from earth into the conductor number 2 is the same; that is, of opposite polarity to the battery current. We have then a simple Leyden jar arrangement of positive and negative electricities, and produce what is familiarly known as the static charge. The experiment being repeated with number 3 conductor, also to earth, the change produces a deflection on number 2 of but 90 divisions on the scale. We then connect another to earth, and the charge produces a deflection of but 70 divisions on number 2. As we connect the remaining wires successively to earth, the effect upon number 2 is gradually reduced until as the last of the wires is attached the galvanometer needle is moved but 4 divisions.

The foregoing experiment shows how the inductive effects are lessened as neighbouring conductors are multiplied, and shows why it was that with additional wires attached to the poles on the route between Omaha and San Francisco the annoying disturbances either disappeared altogether, or ceased to be of sufficient effect to prevent their being used to their full capacity.

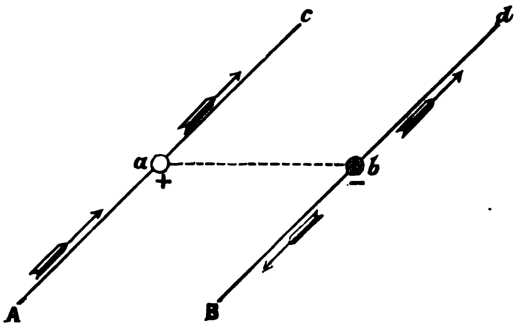

FIG. 1.

Up to this point merely the general principles of induction have been touched upon. Since the advent of the telephone, induction has been an important factor in electrical work, and all of the laws laid down as regards electrostatics seem to be set at defiance. The inductive effect is also found to be much more pronounced upon overhead telephone lines in clear cold weather than when rain prevails. If we take 100 telephone wires strung upon a line of poles, the wires arranged upon 10 cross-arms, each carrying 10 wires, one foot apart in each direction, we have 100 conductors occupying a sectional space of 100 square feet. If these wires extend one mile and are used exclusively for telephone purposes, we observe very marked inductive effects. By using insulated copper wire we may bring these 100 conductors within a space of one square inch. The law of inductive effect between wires is laid down by the authors of the present day as being inversely in proportion to the distance by which they are separated by insulation. Now, in the case of the telephone cable, the conductors are 14,400 times nearer each other than they are when they are in the shape of iron wires

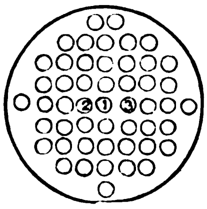

FIG. 2

strung on poles, and the inductive effects should be 14,400 times greater, but we all know that they are not. In the instance of the pole-line we use air as an insulator, which has the least inductive capacity of all substances, Fleeming Jenkin giving gutta-percha over four times, and paraffine twice that of air. It would seem that the inductive disturbance in telephone practice is more of a question of acoustics than of ordinary electrical laws. I know from experiment that cotton or any of the textile materials saturated with paraffine has a much less electrostatic capacity than paraffine itself, and that cotton-covered wire when saturated with oil has much less electrostatic capacity than when saturated with solid paraffine. I can give no reliable data excepting that the more compact the cotton covering and the less oil or paraffine

* Journal of the Society of Telegraph Engineers, vol. iv., No. x., p. 68.

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absorbed by it the less the electrostatic capacity. In experimenting with these materials I am frequently reminded of a patent issued to S. F. Van Choate, November 9th, 1869 (No. 96,641), in which he proposed to obviate the effects of retardation by clothing the wire with a dry textile covering before the insulator is applied.

The following is an extract from his specification and claim:

"Having selected a conductor of suitable size and metal, I proceed to cover it, first with a fibrous wrapping of clean silk, cotton or other equivalent, by winding or plaiting the same upon its surface in such a manner as to form a continuous interposed protection against contact of the wire with the gutta-percha or other preservative, protecting, or insulating material, after which I apply over the fibre a layer or coating of gutta-percha or other suitable substance or material, and otherwise protect said fibre and its enclosed conductor as may seem proper.

"The objects intended by interposing a coating of clean fibre between the conducting wire and the insulating or protecting material may be briefly stated.

"The electrical current which is found to be more or less retarded in case the conductor is covered directly with gutta-percha, asphaltum, or other gummy, bituminous or greasy substance, is, by the interposition of the clean fibrous cushion, saved from such retardation.

"I claim:—

"1. A conducting cable for telegraphic purposes in which a layer of clean, dry, fibrous material is interposed between the conducting wire and the insulating coating in the manner and for the purposes set forth."

Sound is very much deadened by the interposition of liquids. Had the late explosion at Hell Gate been above water, heaven only knows who would not have heard it; as it was, however, people standing but a short distance away heard a comparatively slight rumbling sound made more appreciable by the accompanying vibration of the earth.

One of the most interesting papers ever written upon induction so far as it affects telegraph wires, is that of Richard S. Culley, which was read before the Society of Telegraph Engineers, February 24th, 1875. The paper is not only instructive in itself, but the discussion which followed was exceedingly interesting, and was participated in by Messrs. Preece, Latimer Clark, and Adams. Mr. Culley showed by chemically prepared paper that inductive disturbances between wire and wire were far greater on overhead than on underground lines, and gives the substance of his experience in the following words:—

"As has already been stated, no inductive action could be traced between wire and wire in the underground pipes between the central station and Paddington, although they are four miles and 457 yards long."

. . . .

"Nor is there any record that induction between wire and wire was noticed on the buried wires formerly existing between London and Liverpool."

Mr. Latimer Clark stated "the first and obvious consideration is that we should place the wires (referring to overhead lines) as far apart as possible, and mix them about one among another so that no two wires run parallel for any great distance."

"Between London and Liverpool, a distance of some 210 miles, eight underground wires were laid in 1853. When they were first laid down they were in excellent order. We made a great many experiments on the effects of induction between wire and wire, and with the instruments we then had in use we were quite unable to perceive any induction from one to another. Even when we charged four of the wires suddenly with a strong battery power and put our receiving instruments on the remaining four we could not get any sensible discharge."

All of the recognised insulating materials are affected by temperature. The insulating property of gutta-percha is a hundred times higher at + 100° F. than at the freezing point. India rubber, paraffine, rosin, glass, and every solid substance of an insulating nature is affected by changes of temperature in the same way, but not in so marked a degree. Textile covering, however, like cotton, flax, hemp, jute and manilla show entirely different results. These materials in a natural state may be classed as conductors, but a cable or group of wires insulated with cotton at a temperature of + 300° F., when all moisture is expelled by heat, shows an enormously high insulation, and tests higher in that condition than when immersed in oil at a temperature of + 75° F., and although oil may be said to be affected to half the extent of gutta-percha by changes of temperature, a cable insulated with oil and cotton combined is very slightly affected by such causes, and the more compact the textile covering the less oil absorbed, hence the less affected by change of temperature.

The change of temperature in this climate can be said to range from 100° F. to zero. Under ground the conditions are different; the temperature of water from the hydrant varies between 80° at midsummer and 34° in winter in Philadelphia. As before remarked, inductive disturbance is much more apparent in clear and frosty weather than during rain or under the influence of heat of summer.

Moderately low insulation is the best condition for automatic telegraphing or telephonic operations. But to fix a proper medium to avoid induction is difficult.

Mr. Preece has stated to me that a megohm per mile is better than a higher degree of insulation as regards automatic or high speed telegraphy, and the same law applies to telephone service.

Retardation, which is so often harped upon, is the result of too high insulation. If the conductor has a moderate leak from beginning to end, this impediment does not show itself. Although it is desirable to have the insulation as high as possible when gutta-percha is used, because the higher the insulation the longer the life of the material when used under ground, the insulation can be reduced to a suitable standard for rapid work by putting in artificial leaks in the form of high resistance coils connected to earth at the way stations along the line. Such artificial leaks are placed upon underground wires in Europe to overcome this difficulty where the insulation is too high.

WESTERN UNION METHODS.

UNDER this title the *Financial News* of Tuesday last contained a dispatch from New York, dated December 28th, which said:—

"There has been considerable inquiry of late regarding the exact condition of the American Telegraph and Cable Company's affairs and its relations to the Western Union Company. The cable company owns two cables, which were laid in 1881, at a cost of about $7,000,000 and the company has a capital stock of $14,000,000, upon which the Western Union Company guarantees a dividend of 5 per cent. for 50 years. The company is a member of the cable pool, receiving 22½ per cent. of the pool receipts, against 48¼ per cent. paid to the Anglo-American, 16¾ per cent. paid to the Direct Cable Company, and 12½ per cent. to the French Cable Company. The cable company makes no report direct to its stockholders, what little it cares to divulge being made through the Western Union. The little that can be learned must be learned inferentially and by comparison with the known business of other cable companies in the pool. The recent action of the Stock Exchange in striking the American Cable Company's stock from the list, owing to a dispute about the technicalities of certification, has stimulated speculation as to the actual value of the stock aside from the Western Union's guarantee.

"The outcome of these inquiries has not been particularly flattering, and some uneasiness has been expressed as to the solidity of the contract which the cable company holds from the Western Union. 'That contract,' said a stockholder of the cable company—a man as well versed in telegraphic affairs as any in the city—'is as binding as any contract ever made, and the report that it is so drawn that the Western Union can find a loophole of escape from it is, in my opinion, a report which has no foundation in fact. If ever a company was tightly bound to pay its guarantees it seems to me the Western Union is so bound, and the stockholders will secure their dividends even though their company is a source of loss to the Western Union of many thousands of dollars yearly, as it unquestionably is.'

"The assumption that the Gould cables are a drag upon the Western Union is based on figures officially given by the Direct Cable Company. For the half-year ending in July last, the Direct Company reported gross earnings of £36,106. Assuming that the business for the last six months of the year just ending will show its natural increase, as well as the increase due to the revival of business, their receipts may be put at £75,000 for the year, or $375,000. This will represent 16¾ per cent. of the pool receipts, which is the Direct Company's share. The Western Union Company as the lessee of the Gould cables receives 22½ per cent. of the pool receipts, which, using the Direct Company's figures as a basis of calculation, would be £48,743, or $243,715 for the first six months of the year 1885, or £101,250 for the year, equivalent to $506,250. The operating expenses, aside from repairs to cables, for the Direct Company's one cable in the first six months of the year were £17,206, or $86,000, or should the same rate hold good for the year, $172,000. The working expenses of the two Gould cables, outside of the expense for repairs, and these have been very heavy during the year just closing, would be at a very low estimate $150,000, and will probably be much more.

"The situation occupied by the company to its guarantor is, then, just this: It brings to the Western Union a gross revenue during the year now closing of $506,250. The Western Union pays out as against this receipt the guaranteed dividend of $700,000 on the capital stock and $150,000 for operating expenses, in addition to an unknown sum for repairs to the cables. Both cables were broken last February. The attempt made to find them in the winter had to be abandoned, and another attempt was made in the summer with success, the cables being again in use in September. Both attempts were, of course, at great expense. This was made apparent by Dr. Green, President of the Western Union Company, who in his recent report advising the reduction of dividends said the necessity for such reduction was due to extraordinary expenses incurred for litigated taxes—which, so far as this State goes, don't appear to have been paid yet—and for repairs to cables. As an offsett against this deficit the Western Union Company has, by its contract with the Cable Company, a uniform income of two cents a word for every word transmitted through it. Even this additional income is not sufficient to wipe out the deficit between the recipts and the regular charges—dividends and operating expenses—by many thousand dollars.

"With such a showing the American Telegraph and Cable Company shareholders are anything but satisfied. So far as can be ascertained there is no fund set aside as a renewal to be used in the construction of new cables when those now in use shall be worn out. Every other cable company has such a fund, based usually on the theory that the life of a cable will be but sixteen years. To the renewal fund there is yearly set aside, by some of

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them, 6 per cent. on the actual cost of the cable. The Direct and Anglo-American have large renewal funds; the American none at all apparently. Naturally the stockholders of the latter company ask, 'What will become of us when our cables are worn out?' and 'What will become of us when the Western Union guarantee expires, if it lives and continues to pay us our dividends for fifty years?' A satisfactory answer has not yet been given. Active and formidable opposition in the cable business, and the constantly and rapidly decreasing earnings of the Western Union Company have put these stockholders on the anxious seat. This is especially the case since rival cables have been projected, and seem likely soon to be constructed.

"The only source of consolation which the stockholders find is the fact that their cables are comparatively new, and are known to be good ones, having been made by the Siemens Brothers, of London, who constructed the Direct, the French, and the Mackay-Bennett cable. They have met with no more accidents than have befallen other cables, and in case of breakages, which are repaired at any time within a year from the time of breakage, their lessees will receive their share of the pool receipts, in accordance with the provisions of the pool agreement."

Commenting editorially upon the subject, our contemporary remarked:—

"In connection with the recent action of the New York Stock Exchange in striking the American Cable Company's stock from its list the American journals are again discussing the evils of the stock-watering practices so popular with the cable companies. According to the *New York Times*, the 'pooling' system has its advantages as well as its disadvantages for honest stockholders, and one of them is that under it secretive directors are powerless to keep from the public the amount of a corporation's earnings, provided any other company in the pool publishes a statement of its own. From this it is easy to calculate to an approximate certainty the receipts of all the other members of the pool, so that stockholders cannot be kept in ignorance of the fact of their property, by reason of mismanagement or otherwise, is expending more than it is receiving. This calculation, applied to the American Cable Company, which has leased its wires to the Western Union on a 5 per cent. guarantee of its $14,000,000 of stock, shows that the Gould Cables are an expensive luxury for the telegraph company to hold as a plaything. During the year just ended the 5 per cent. dividends guaranteed by the Western Union Company, with the running expenses and cost of repairs, have not only eaten up all the receipts from the business of the cables, but from $200,000 to $300,000 besides, which represents an absolute loss to the telegraph company. It may pay the Western Union to maintain the American Cable Company at this exorbitant rate merely to frighten off other cable companies, but, says our contemporary, business men, who deal in tangible properties instead of watered stock, will not regard this as a judicious investment. It is possible that the figures arrived at by the New York Stock Exchange Committee, which showed the utter worthlessness intrinsically of the cable stock, may have been the real cause for dropping that stock from the Exchange list, an act for which 'technical errors of certification' was given as the reason. But the exposure of rottenness in anything controlled by Jay Gould can no longer be a matter of surprise to the initiated."

OVERHEAD WIRES AND THE RECENT STORM.

At a meeting of the Board of Works for the Wandsworth District, last week (Mr. G. P. Meaden presiding), the Surveyor (Mr. Pilditch) reported that the storm of the morning had done considerable damage to the overhead wires in Battersea, that several of the posts on housetops had been broken down, and that in many cases the wires had been coiled round the lamp posts. The chairman (referring to the recent litigation of the Board with the Post Office on the subject) said this was just what the Postal authorities said would not happen. Mr. Morton suggested that the Board should communicate with the Home Secretary on the subject. Mr. Lidiard said there was no doubt serious damage had been done, and he thought the Board should obtain information from all parts of London. Mr. Wood moved that the Board should write to the various Local Authorities in the Metropolis in order to obtain the fullest information possible. Mr. Sidland seconded the motion. The surveyor stated that the broken wires were the new copper ones, which they had been assured would resist such influences, but they had been the first to go. The resolution to communicate with the various Vestries and District Boards was unanimously agreed to.

A fire broke out early on Wednesday morning, last week, on the premises of Messrs. Duffy and Son, saw mills proprietors, in Vauxhall. The heavy storm had disorganised the electric fire alarm, and the state of the roads prevented the rapid arrival of the engines, so that the fire had made great headway before attempts could be made to extinguish it.

A number of letters have appeared in the various daily papers upon the subject, for the most part dwelling upon the danger to life and limb caused by the overhead wires. Messrs. Beal, Son and Chartres, of Waterloo Place, give the following account in the *Times* of an experience of theirs:—

"We had so narrow an escape of our lives here yesterday that it is as well to record it as a protest against overhead wires. A large skylight covers one of our offices, and, owing to the breaking of the connections of one of the trunk wires, portions of the parapet of the adjoining house were hurled through the skylight, of a weight sufficient to have killed any one seated therein. No one for the istant was in the room, but the chairs in which they would have been seated bear evidence of the force at which the stone and brickwork descended. The company have acknowledged their liability, but the moral we venture to draw is 'No more overhead wires.'"

Mr. George Russell, replying to a previous letter, wrote, also in the *Times*:—"In Mr. Beachcroft's letter about overhead wires, he refers to the report presented by the Select Committee, of which I was chairman. Permit me to say a few words in self-defence. After a careful examination of exhaustive evidence, the Committee did not feel justified in recommending the total discontinuance of overhead wires. But, in the draft report which, as chairman, I proposed to the Committee, I urged the following precautions:—All overhead wires should be subject to proper supervision. Overhead cables should not be permitted. Where more than 10 wires are run along a line, the local authority should have power to compel them to be taken underground. The local authority should also have power to regulate the length of span, and other conditions necessary to secure the safety of the public. No power to pass and keep wires over private property without the consent of the owner or occupier should be given to any company or private person. All owners of land or occupiers of houses should have power, by notice to the local authority, to cause the removal of wires crossing their property and belonging to any company or private person. No company or private person should have power to make attachments to houses or buildings without the consent of the owner or occupier. By-laws for the regulation of all wires, as to substance, length of span, durability, &c., should be made for the whole of London by the Metropolitan Board of Works. Every wire should be registered with the local authority, and all ownerless wires be removed. The duty of inspecting wires and maintaining them in proper order should devolve on the owners, who will be responsible for the results of neglect. These precautions were rejected by the majority of the Committee, and a report was presented, inconsistent, in my judgment, with the public safety and the rights of private property."

Mr. J. F. B. Firth is determined to make the occasion serve his particular purpose, as may be gathered from the following letter, which, however, does not seem to make quite clear the point with which he desires to impress us; still, his letter is interesting, and we reproduce it. He says:—"The breaking of overhead wires in the recent snowstorm will not be without its advantage if it compels Parliament forthwith to legislate on the whole question of telephone and telegraph wires. A Select Committee of the House of Commons considered the question last session, and by a majority reported in favour of an extension of the powers of companies and of granting them authority to pass wires over private property and to attach them to private buildings without the consent of the owners. The minority of the committee were in favour of much more stringent regulations with respect to overhead wires. I venture to think that the recent breaking of wires in London has strongly emphasised the necessity of such restrictions as they recommended. In the *Times* of Friday you printed a letter from my old friend Mr. Beal detailing the effect of a falling wire, from which it appeared that the preservation of his life was only due to his temporary absence from his official chair. It would have been a Nemesis indeed if a man who has devoted an arduous life to the advocacy of the establishment of a competent local authority in London had borne witness by his death to the necessity of such an authority. The wire which fell was one of the heavy cables or trunk lines which cross the streets in all directions. These bundles of wires ought in all cases to be put under ground, and the minority of the committee were of the opinion that wherever more than 10 wires were run along a line they ought also to be taken underground. There is very little danger in a sound, properly attached, overhead wire of reasonable span, but provision ought to be made for its frequent inspection and for its renewal at stated periods. The Post Office, as a great public department, exercising its functions for the benefit of the whole community, has made provisions to this end, and may be relied upon to extend them by the light of recent experience. The need of legislation is greatest in the case of private wires. The great increase of breakages in the recent snow-storm over the storm which visited us five winters ago was due, not so much to a heavier fall of snow, as to the increased age of the wires; and unless we have effective legislation forthwith it is likely that a future storm of similar magnitude will produce far more disastrous results. The Post Office authorities know pretty well what is the length of the life of a wire. In the pure country air it will last nearly 30 years; but in air like that of Newcastle-on-Tyne, impregnated with sulphur and acid, it will not last three years. London air is better than the air of Newcastle, but there are many thousands of wires crossing our streets that are in a period of advanced decay. The danger from these wires increases year by year. The Post Office authorities, with increasing knowledge of the conditions and effect of our atmosphere and of the best wires to use, are increasingly careful in their system of inspection and renewal. But there is no control over the wires of private companies and persons. Worse than this, there are in London an enormous number of ownerless or derelict wires. They have been put up at some time for the purpose of communication, and when for any reason they are no longer required they have been left in order to save the trouble of removing

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them. Anyone can satisfy himself of this if he will note the pillars carrying wires and which show sometimes as many as five or six coming to an abrupt termination. The right to erect wires at all ought to be the subject of properly-regulated control. At present it is the custom of both companies and individuals to stretch wires in any direction they please, over both private and public property. This is an undoubted infringement of the rights of private owners, but one of so small and peculiar a character that it is not often challenged, and indeed, as the wires are often erected at night they are not always noticed. While it may be admitted that the Post Office, acting under full public responsibility, should have power to pass and keep wires over private property without the consent of the owner or occupier, it is doubtful whether such power should be given to any private company or person. It is surely not too much to ask that every wire should be identified and registered with the local authority. There ought to be by-laws regulating the period of renewal, the length of span, and the substance of the wires, and no wire ought to be erected by an irresponsible person or company except with the consent of the owners of property and of the road authorities of the district through which it passes. Immediate legislation is necessary for London. The needful by-laws may be made by the Metropolitan Board of Works, and the needful registration and control placed in the hands of the London vestries. Every legislator walking down Pall Mall in a snowstorm incurs the risk of decapitation. Surely we need not wait for this catastrophe before removing the danger."

THE ELECTRIC TRAMCAR IN BERLIN.

WE are pleased to observe that the German newspapers, scientific and non-scientific, are unanimous in their praise with reference to the Reckenzaun car, which has now been some weeks before the Berlin public. Saturday last appears to have been a grand day. At the invitation of Herr. G. A. Plewe, gentlemen interested in tramway matters came from all parts; there were directors and engineers from Stettin, Hamburg, Cologne, Vienna, Potsdam, Aix-la-Chapelle, Charlottenburg, Magdeburg, Dresden, Spandau, in addition to those of the Grosse Berliner Pferdebahn, present on Saturday morning and afternoon. It was, in fact, a kind of congress of specialists, who made it their business to watch the performance of the vehicle, which has caused quite a sensation for some time past; and the result is, according to reports from several leading papers, that the boards of directors of the Berlin tramways, the Stettin and the Potsdam Tramways, have resolved to equip a number of cars forthwith with the electric apparatus, whilst all expressed their approval of the system. The car in question has for several days been under the entire control of officers of the Grosse Berliner Pferdebahn, and Mr. Reckenzaun was but a spectator during these official tests; the ease with which uninitiated persons could regulate the speed, start, stop, and generally control the vehicle caused great admiration and surprise on all hands. It appears that Mr. Reckenzaun has on the Berlin car introduced some substantial improvements, which were not on the one exhibited in London last year. The most difficult routes of Berlin were chosen; the car was overloaded every time with at least six persons, sometimes ten, above the regulation number, but every demand that could be made by the critics was at all times satisfied.

The Grosse Berliner Gesellschaft is probably the largest of its kind in Europe; it owns 620 cars and 5,000 horses; it pays yearly increasing dividends which amount now to 10 per cent.; it is, therefore, all the more praiseworthy that innovations of a promising character are being supported by this company. When will sufficient enterprise be forthcoming in this country to go and do likewise? We have already given descriptions of the Reckenzaun car and enumerated its many advantages; we need not, therefore, reproduce the lengthy articles of our contemporaries, but we must join them in their praise and their warm congratulations on the success of the system.

The Electric Light in the Royal Navy.—The Admiralty have directed that the sister ships *Alacrity* and *Surprise* shall be fitted at once with electric search ights as well as internal electric lighting.

NOTES.

Temporary Electric Light Installation.—On the occasion of the exhibition of pictures of the Alpine Club at Willis's Rooms, three of the rooms, viz., the card room, about 24 × 24 feet; the new room, 24 × 33 feet; and the tea room, 24 × 42 feet, were lit up by forty 20 c.p. Woodhouse and Rawson incandescent lamps suspended from the ceiling; the lamps being silvered were specially suitable, reflecting the light on to the pictures. Messrs. Woodhouse and Rawson, who were the contractors, had not much time allowed them, as three-fourths of the lighting had to be arranged for and carried out on the opening day of the exhibition before 3 o'clock; the work, however, was done as if for a permanent installation, and in accordance with the rules of the Phœnix Fire Insurance Office.

Electric Lighting in Hull.—Some time ago the Hull Corporation granted £10,000 to its Lighting Committee for the purpose of experiments in electric lighting. A number of arc lamps have now been erected in the Victoria Hall, and it is anticipated that the arrangements for the lighting of the hall will be completed in time for the coming musical festival to be held therein.

Domestic Electric Lighting. — Mr. F. Bumsted, of Cannock Chase Foundry, gives us the following information respecting the electrical plant at his house. The installation has been in operation for a few weeks and it is entirely satisfactory. There are 30 E. P. S. Co.'s cells, charged by a "Phœnix" dynamo, driven at 750 revolutions per minute by a small "Chandler high-speed engine" and vertical boiler (steam pressure 40 lbs.), mounted on four wheels; this, however, is only a temporary motive power, as Mr. Bumsted is now putting down a "Davey" motor. The E. P. S. cells serve 40 lamps.

The Thomson-Houston Electric Lighting System. The Thomson-Houston Electric Lighting Company has during the past year formed no less than 51 subsidiary companies in the States and elsewhere, and the number of lamps operated by these companies, with those added to other installations previously existing, reaches the respectable total of 6,900.

Electric Lighting at Hatfield House.—On the occasion of the county ball given by the Marchioness of Salisbury at Hatfield House on the 6th inst., the following arrangements were made for the lighting by electricity of the house and grounds. The principal rooms, galleries and grand staircase were illuminated by upwards of 900 Swan's 20 candle-power lamps; the principal power for these lamps being derived from two waterwheels on the river Lea, which is a mile and a quarter distant from the house. The machinery used for generating the current consisted of two Siemens alternating current machines, one 16-light "Brush," and one Siemens direct current machine, the latter being driven by a 16 H.P. gas engine. The terraces and approaches to the house were lighted by six Clark-Bowman arc lamps, the current for these being supplied by an H gramme machine driven by a traction engine near the house. The lighting was in every respect a thorough success and gave great satisfaction, there being not the slightest interruption to the working during a period of 16 hours. The whole installation was carried out by Mr. Shillito. It may be remembered by our readers that the Marquis of Salisbury has been a pioneer in the matter of electric lighting and the use of electricity, and that his lordship has utilised this agent in a variety of novel ways by the transmission of electrical power, such as for grinding corn at farms situated at some distance from the water-power, pumping water and driving the ventilating apparatus at the house, driving the lathes and saws in the workshops, pile driving, dredging and cutting weeds in the river, &c.

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A Powerful Blaze.—A Chicago dispatch in the *New York Times*, dated December 31st, says :—"The highest and most powerful group of electric lights in the world is to-night blazing around the tower of the Board of Trade Building, at the foot of La Salle Street, a little over 300 feet above the ground. While the building was in process of construction the idea of crowning its highest point with a ring of lights was suggested by Elmer A. Sperry, a Cornell University man, 25 years old, who came here from Cortland, N. Y., three years ago and formed an electric light motor, and car brake company. Various circumstances prevented the execution of the scheme until the present time. Mr. Sperry's company put up the lights, the Board of Trade furnishes the power, and the other expenses are paid by subscriptions from owners of surrounding property, including the Federal Government and several railroad companies. There are 20 of the lights, and they are fastened to a ring of 4-inch gas pipe 29 feet in diameter. The ring hangs on steel wires three-quarters of an inch in diameter, running over sheaves placed at the extremities of four arms projecting from the tower near the top. By these ropes, which are attached to drums in the clock room, the lights are lowered, when necessary, to a balcony surrounding the tower at the dial, 68 feet below. The lights are of 2,000 candle-power each, and are connected with a 20 light dynamo of 29 ampères in the basement. The carbons will burn 15 hours if necessary. The lights are to burn every night in the year. To-night the glowing crown is visible from every part of the city and for miles away. It is reported that it can be seen at Michigan City, 60 miles distant across the lake. It is thought that the light can be seen from a point in the lake off Milwaukee. The railroad yards of the city are greatly benefited by the light."

The Electric Light on the Lyceum Stage.—A writer in a dramatic contemporary says :—"I am told that new wonders of electricity are to be introduced into the representation of 'Faust'. Sir F. Bolton is devising, or has devised, a scheme by which Mr. Irving can carry three different coloured lights in the inside of the peak of his cap. By means of these he can illumine his features as he chooses. The last few years have indeed seen remarkable changes in stage-lighting. Different coloured lime-lights thrown from the wings or other parts of the stage were accepted not long since as amazing inventions, though the flood or stream of rays which came from the machine crudely betrayed the origin ; but this will soon be obsolete. Another of the ingenious electrician's contrivances for Mr. Irving is to be a sword so charged that he can at will produce an electric light on the point. When Valentine has fallen, Mephistopheles will point to him contemptuously with this weapon, and the face of the dead man will be illuminated. I am afraid 'Spectator' will not approve, but I think the device will be extremely telling."

A further statement is that the moon in the Brocken scene is likewise to be charged, and will at a given time send out forked lightnings.

The Electric Lighting of Pianos.—Electric lighting by the application of storage batteries to pianos is now being developed. The case of the instrument conceals the materials for an illumination lasting over ten hours.

The Electric Light on Steamers.—The latest addition to the line of steamers owned by Messrs. Wilson, Sons and Co., the *Torpedo*, has been fitted with the electric light, by Mr. Thomas Muse, of Hull. A Paterson and Cooper's Phœnix dynamo supplies the current, and beside the usual incandescent lamps below, the installation includes side and masthead lights, which, under the new system, are said to be more satisfactory than formerly. This is the sixth of the Wilson line to be lighted by electricity, and as the others of the fleet lay up for repairs, they also will be lighted.

Electric Lighting at Hull.—Messrs. Barnett and Scott, jewellers, Whitefriargate, Hull, have had their premises lighted by electricity, and a number of representative men of the town were present, by invitation, to witness the inauguration. Electricity as a means of lighting the public streets of Hull was tried some time ago by the corporation, but after a time discontinued ; and it has also been used at dock, railway, and one or two large works in the town, but Messrs. Barnett and Scott have been foremost in its introduction to shop premises. A powerful gas engine has been placed in the back premises, and this is the motive power for supplying electricity throughout the establishment. After a test of the lighting had been made, the company present partook of refreshments, and the Mayor proposed the health of Messrs. Barnett and Scott, in responding to which Mr. Barnett said the burning of gas in their show premises and workshops had been found to be injurious to the health of their assistants and workpeople generally, and to have a damaging effect upon their goods ; this had led to their trial of the electric light, which did not give off heat and fumes, as gas did. The plant consists of a 6 H.P. Otto gas engine, which has been laid down by Messrs. Crossley Brothers, Limited, a Ferranti dynamo, and a Siemens exciter. The lamps are the Woodhouse and Rawson incandescent, of 20 candle-power each, and they are arranged suspended from chandeliers on either side of the extensive shop, six lamps forming a cluster. A sun-light of lamps is fixed in the centre of the ceiling, and eight lamps in each compartment of the window. The whole of the lamps in the shop give an illumination stated to be of 2,000 candle-power, producing a most brilliant effect. The offices and workshop will also be fitted with the same light. The installation has been carried out under the direction of Mr. Thomas Muse, electrician, of Hull.

Station Lighting at Glasgow.—The experimental lighting by electricity of the Central Station, Glasgow, has proved so successful that the system is about to receive important additions. Within a few days five or six lights will be added to the existing number. Of these one will be placed outside the covered way at the Gordon Street entrance, showing as far as Buchanan Street and Hope Street, another at the exit in the latter street, and a third will be erected on the parapet of the Argyll Street Bridge. The engines fitted up are powerful enough to supply electricity to the Bridge Street and Eglinton Street Stations.

The Electric Light in the Manchester Art Gallery.—Mr. Alderman Hopkinson, at the recent meeting of the Manchester City Council, in moving the adoption of the proceedings of the Art Gallery Committee, said the electric light had been an immense confort and advantage, although it was not altogether perfect yet.

Electric Lighting of the Wallasey Steamers.—At the last monthly meeting of the Wallasey Local Board, the minutes of the Ferry Committee included a resolution as to the placing of electric lights on the Wallasey steamers. When this improvement was effected, there was no doubt whatever that all persons residing in the parish would be highly pleased. It was said that the total expense would be £764. The oil lamps cost £17 15s. per annum ; the electric light would only cost £7 10s. The minutes were adopted.

Electric Head Lights.—The Chicago, St. Louis, and Pittsburg Railway Company (Panhandle) and the Cincinnati, Indianapolis, St. Louis, and Chicago Railway Company (Big Four), have taken the electric head lights off engines where they have been trying them for some months. The light has given satisfaction on all sides, with the exception that it is so bright and strong, that it makes the signal lamps rather dim. The drivers, however, would probably become used to them, and this would be no objection. The companies claim it would cost them about 400 dollars for each engine to fit them up for electric light, which is more than they can afford at present.

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Station Lighting at Edinburgh.—About the time the electric light was tried in Princes Street, Edinburgh, some years ago, the North British Railway Company introduced it for the lighting of the Waverley Station. The Railway Company has found it to its advantage to continue it; and the improvement in the lighting of the station is said to be most marked. The directors have just completed an extension of the electric light to the refreshment and waiting rooms, the booking hall, &c., and to the entrances and platform of the Suburban Railway platform. The lights, which have been in use up to the present time, are on the arc system; while the extension which has just taken place is on the incandescent principle. About 135 such lamps have been fitted up, each combination being of 20 to 30 candle-power. The different departments are arranged in groups, so that one set may be lighted while the other is not. The new lights will be run with the present engine power. In that way the working expenses will practically represent only the cost of the additional coal required. Taking that with the interest on the price of the lamps, and the amount which will be written off for depreciation, the Railway Company estimate that the station will be lighted by the electric light at about half the expense of gas. Economy is certainly one of the objects kept in view, and another is the preservation of the appearance of such rooms as the refreshment rooms—an expensively painted ceiling in one of which has been greatly blackened by gas within four years. The work has been carried out by the Anglo-American Brush Electric Light Corporation, under the direction of Mr. Geipel, their superintendent, and Mr. Thomas Carswell of the North British Railway engineering department.

The Telephone in Austria.—According to a *Times* telegram, the use of the telephone is fast extending in Austria. Communication has just been established between the town of Gleichenberg, one of the principal industrial centres of Bohemia, and Gablonz, another manufacturing town 12 miles distant.

The Telephone at Cardiff.—The Western Counties and South Wales Telephone Company has just opened a telephone exchange at Cardiff. The rooms of the company occupy the whole of the top floor of the central block of the New Exchange Buildings in Mount Stuart Square. There are two services, the "commercial" and the "domestic." The former embraces day and night communication, exclusive of Sundays, and is connected with the postal telegraph office, by means of which subscribers may receive or forward their telegrams without extra charge by the company, and the free use of any call rooms which may be opened in the town. Connection will also be established with the central police station and fire office. It is also proposed to connect the service with the leading cab-stands. The cost of this service for any distance within one mile of either of the exchange centres is £14 if for one year, £13 per annum if for four years, and £12 if for seven years. The "domestic" service is open from 9 a.m. to 6 p.m. daily, Sundays excepted, the distance being limited to within one mile of either of the centres. This service—the cost for which is £12 for one year, £11 per annum for four years, and £10 for seven years—embraces communication during the before-mentioned hours, and the free use of any call rooms which may be opened in the town. Through communication between Cardiff and Newport is obtained by trunk lines provided by the company for those who are subscribers to their exchange in either or both towns at the rate of £6 per annum for a single connection.

The Telephone at Fire Stations.—At the last monthly meeting of the Burton Town Council it was suggested that the utility of the suburban fire stations should be increased by telephonic communication between them and the borough brigade stations. The suggestion was to be considered.

Invention of the Telephone.—Dr Lawson Tait, of Birmingham, has written the following letter to the *Scientific American* upon the subject of the invention of the telephone:—"I have read with much interest your articles on the invention of the telephone originally by Reis. I have also read the work of my friend, Prof. Silvanus Thompson, on this subject, and I have discussed the matter with him. I think I am in a position to supply a small link in the chain of evidence, which, though not important, may really prove to have a good deal, and certainly is not devoid of interest. I was a student of medicine in the University of Edinburgh from 1860 to 1865, and being much interested in physical research, I was very frequently in the shop of Messrs. Kemp & Co., which used to stand near the entrance of the old Edinburgh Infirmary. Probably many of your readers have, like myself, visited that well-known establishment, and they will remember that it consisted really of two shops—one in which chemicals were sold, and the other, which had a separate entrance from the street, yet connected with the first by a door of communication, was occupied chiefly by physical apparatus, and was not common to the ordinary customers of the shop. Mr. Kemp died somewhere about the year 1861, and the business for some time, until, I think, about the middle of 1864, was managed by an extremely intelligent assistant named Mr. Shearer, of whom for many years I have entirely lost sight. Could Mr. Shearer be discovered, I fancy that he could give some extremely interesting information about the point which I am about to indicate. As near as I can identify the date, in December, 1862, a very simple looking instrument was shown to a number of his customers by Mr. Shearer. That instrument is depicted accurately on page 342 of your journal (Nov. 28th, 1885). It was connected in a circuit with a battery, and by means of wires to a transmitter of a rather different form from that which you figure on the same page, but precisely identical with one which is figured on page 97 of Professor Silvanus Thompson's work. Mr. Shearer had his apparatus in action, the transmitter being arranged in one shop, while the wires passed through to the receiver in the other. In common with many others of those who frequented the shop, I heard articulate words, which I could appreciate accurately, pass through this instrument from one shop to the other. At that time Mr. Alexander Melville Bell was a well-known teacher of elocution in Edinburgh, giving public readings, to which many of the young men of the town were strongly attracted. He was, indeed, a very well-known man in Edinburgh, and lived there with his family. When I met Mr. Graham Bell at Plymouth, in 1877, when he first exhibited his telephone, I immediately recognised him as the son of Mr. Melville Bell. I cannot say whether he was resident in Edinburgh at the time that Shearer exhibited Reis's telephone in Kemp's shop, but I think it is very likely he was, and I feel almost certain that I have seen Mr. Melville Bell as one of the frequenters of that shop. So that it seems to me that nothing is more likely than that it was through this chain that Reis's telephone was transferred to America, and there became developed. Mr. Melville Bell was then engaged in the contrivance of a universal alphabet, upon which he has published an extremely interesting book. Reis's telephone was greatly talked about in Edinburgh at the time of its exhibition by Shearer, and I think it is extremely likely that Mr. Melville Bell would go to the shop to see it, and he might have been accompanied by his son."

The Telephone at Prescot.—At the last monthly meeting of the Prescot Highway Board, the surveyor said he had had an application from the telephone company to erect several poles for the extension of the telephone wires for the use of the county constabulary, in Sandy Lane, south of the workhouse, Narrow Lane, and St. James's Road. He did not think there could be any objection. The board decided to leave the matter in his hands.

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The Bell Telephone Case.—The *Scientific American* of January 2nd contains the following:—"Associated Press reports state that the Interior Department has decided to recommend that the Attorney-General authorise suit to be brought in the name of the United States to test the validity of Bell's original patent. Although the full text of the decision will not appear for some days, it is said that it will set forth, among other things, that 'the specification of Bell's patent contains nothing about the capability of Bell's instrument to transmit articulate speech, but only claims for it the power to transmit "vocal sounds;" that an instrument may transmit "vocal sounds" without being a speaking telephone; and that, in point of fact, Bell did not invent a speaking telephone until after the issue of his patent, as appears from the record.' For these reasons, it will be urged, the validity of the Bell patent is fairly questionable."

The Drawbaugh Telephone Case.—According to the New York *Electrical Review* of January 2nd, the Drawbaugh telephone syndicate held a meeting in Boston on the previous Friday, and considered a communication from Senator Edmunds, recommending an appeal from the decision of Judge Wallace. It was voted to make the appeal prior to January 1st, and the expectation is that the Attorney-General will see that the case is placed upon the calendar so as to insure a hearing this winter.

The Telegraph in Canada.—It is stated in Canada that before many months have passed an independent system of electric telegraph will be opened by the Canadian Pacific Railway Company. As a commencement the company is already erecting between Montreal and Winnipeg wires of exceptionally large capacity, and when completed these two cities will be in as close and quick communication as are Toronto and Montreal. The facilities of communication, too, between Montreal and Ottawa, already large, are in process of being more than doubled.

Postal Telegraph Festivities at Plymouth.—On Thursday, last week, the annual dinner of the clerks employed at the Plymouth Postal and Telegraph Offices took place at the Farley Hotel, under the presidency of Mr. J. N. Foot. The toasts included, "The Postmaster-General" and "The Telegraph Staff." During the evening Mr. Charles Collings was presented with a microscope in recognition of his services for 10 years as hon. secretary of the Postal and Telegraph Service Benevolent Society.

An Important Appointment.—The New York *Electrical Review*, of December 26th, contains the following announcement:—"The many friends of Sr. Saturnino Islas, of the City of Mexico, will be gratified to learn of his appointment as Director General of all the Government telegraph and telephone lines in the Republic of Mexico. Sr. Islas is eminently fitted for the high position thus conferred, having had many years' experience as superintendent of telegraph for the Mexican railroad, and has ever been prominently identified with the telephone and electric light in our sister Republic. The Mexican press speaks in the very highest terms of his work of reform already inaugurated, and we predict a bright future for him. He is possessed of great executive ability, and his integrity is known to be irreproachable." Sr. Islas should make an efficient Director-General, having been trained in the telegraph department of the English Railway Company, whose lines connect Vera Cruz and the City of Mexico, and of which he became telegraph seperintendent. He was an officer in the Mexican army during the French invasion, and distinguished himself.

Large Telegraph Contract.—A Wolverhampton firm, Bayliss, Jones and Bayliss, has obtained an order of the value of £50,000 for the supply of wire and fittings to the Indian Telegraph Company.

Telegraphic Communication in Bulgaria.—In virtue of an arrangement between the authorities at Phillippopolis and Adrianople, railway and telegraphic communication with Eastern Roumelia, which has been suspended since the outbreak of the revolution, will be re-opened in a few days.

Telegraph Poles in Dangerous Positions.—The Chairman of the Prescot Highway Board at a recent meeting drew attention to a pole erected opposite the almshouses in Warrington Road, and which, he said, was very objectionable. The Surveyor said the pole in question was a telegraph pole, and had been erected by the postal telegraph officials. He had several times ordered poles to be put further back, and he had given instructions that no more were to be put down without his consent. He had written on the subject. Mr. Leatherbarrow asked if they had any power over the poles. Could the Government place them where they liked? The Clerk: No; they must have our consent. Mr. Leatherbarrow said a man recently walked against the pole, and he had to be carried home insensible. The pole had been painted white, but it could not be seen on dark nights, as there were no lamps about. It was resolved that notice be given to the Postmaster-General that unless the pole be removed within fourteen days the board would remove it and charge him with the cost.

Telegraph Poles at Oxford.—At the last monthly meeting of the Oxford Local Board, the recommendation of the General Purposes Committee, that application be made to the Postmaster-General asking him to remove the nine telegraph poles north of St. Margaret's Road, and to substitute underground wires, was adopted.

Telegraph Revenue.—The receipts upon the telegraph revenue from April 1st, 1885, to January 9th, 1886, amounted to £1,345,000, against £1,355,000 received from April 1st, 1884, to January 10th, 1885.

Electrically Protecting the Dead.—Electricity has been invoked to secure the tomb of the dead millionaire, Vanderbilt. The niche in the vault in which the coffin is placed is connected with an electrical alarm, and even if a tunnel could be driven to the tomb, any attempt to remove the body, or any tampering with the wires of the alarm, would be made known immediately at the head-quarters of the detectives. A registering alarm clock has been placed near the gate of the vault, and at short intervals the guard is required to register his presence at the tomb.

Mysterious Death.—Mr. Langham, the Coroner for West Middlesex, last week opened an inquiry respecting the death of a young Dutchman, John de Wilde, aged about 25, a telegraph instrument maker, whose body was found in the River Thames below London Bridge, embedded in the mud, and whose forehead bore evidence of foul play. The deceased was last seen with another foreigner, named Degenkolb, who attended the inquest, but whose evidence was refused, as he was an atheist and declined to take the customary oath. The inquiry was adjourned.

More Anglo-American Cables.—It is reported in Glasgow that the Anglo-American Telegraph Company is contemplating the laying of two new cable wires to America "to meet the large and increasing business." But we do not quite think Glasgow is the best place to go to for the purpose of learning the intentions of the directors of the Anglo-American Company.

Corrections.—We stated in error last week that the paper on the dynamo, by Mr. W. M. Mordey, which we published, appeared in "the Journal of the Physical Society," instead of "in the *Philosophical Magazine*."

In the letter of Mr. Aug. J. Littleton, on page 44, last week, it is stated that the dynamo gives *above* eight available E.H.P.; this should have been *about* eight.

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Science in Japan.—The Minister of Education at Tokio, Japan, has obtained leave to have translated into Japanese Prof. Guthrie's syllabus of instruction in elementary practical physics, as pursued at the Physical Laboratory of the Normal School of Science and Royal School of Mines, South Kensington. The Japanese Government proposes to introduce this system of practical instruction into the elementary schools as well as into the normal schools of Japan. Prof. Guthrie has promised to write a preface to the translation.

A Novel Desk.—Mr. F. J. Davis, of Plymouth, and Mr. E. H. Middleton, of Devonport, have jointly invented what may be described as a portable illuminated desk, which promises, if its merits can be proved, to be of great utility on all occasions when the light of nature is not available. The desk is in shape not unlike an ordinary street lamp, with the exception that wood takes the place of glass. By the pressing of a spring at the lower part of the front the desk opens and affords every facility for writing. It is stated that the light for this desk can be supplied with equal facility by means of electricity, gas, oil, or candle. It is suitable for a sick room, the bridge of a steamer, mines, or open air meetings, and one has already been fitted on board the bridge of the P. and O. steamship *Bengal*. It may be added that the desk is both water-tight and air-tight, and has the additional merit of being ornamental as well as useful.

Electric Railroads in Boston.—A project is on foot to build and operate elevated railroads in Boston on which trains are to be run by electricity. No particular system is yet mentioned.

The Gaulard and Gibbs System.—The National Company for the Distribution of Electricity by Secondary Generators has issued a pamphlet explanatory and descriptive of the system of distributing electrical energy invented by Messrs. Gaulard and Gibbs. It commences with a chapter on "The Advantages of Electric Lighting," and, throughout, is written in an interesting manner.

Electrical Subjects in American Newspapers.—Our leading journals would do wisely to follow the example of those of America, which invariably pay great attention to electrical subjects, and give no small amount of space to them. In illustration of this we may cite the case of the *New York Times*, which on January 1st contained between eight and nine columns dealing entirely with such subjects as the telephone, electrotyping, electric lighting, primary batteries, India rubber, &c. We can scarcely expect emulation of this record, but we should like to see the daily papers treat the electrical industry as "a real live thing."

The Franklin Institute Incandescent Tests.—Reverting to the matter of Messrs. Woodhouse & Rawson's lamps and the tests at the Franklin Institute, the *Mechanical World* replies to our concluding query upon this subject a fortnight ago, that it "would not matter a bit" to the Franklin Institute what names certain lamps bore if they were properly entered for the tests, "but that was just the point at issue." Then our contemporary says :—"What Messrs. Woodhouse & Rawson complain of is that the lamps were entered without their knowledge, that they had no means of watching the tests or of protesting against them before they were complete." What we have to say is that if Messrs. Woodhouse & Rawson had read the technical journals of this country or of America, they could not have overlooked the paragraphs periodically given, calling attention to the progress of the tests. The circumstances attending the tests on these particular lamps are unfortunate, but we repeat that the Franklin Institute is exonerated from all blame in the matter; and to those who doubt this assertion, we say, Read the report.

Obituary.—In Mr. George Richardson, the Receiver and Accountant-General of the Post Office, who died on the 6th instant, the country has lost a public servant of great experience and capacity. He entered the Post Office in 1845, and was at first employed in the Money Order Department, which he left in 1861, in order to take an active part in the organisation of the Post Office Savings Bank. He subsequently performed much arduous and responsible work, notably in connection with the transfer of the Telegraphs to the State and the establishment of the Postal Order system. He was appointed Assistant Receiver and Accountant-General in 1877, and succeeded the late Mr. George Chetwynd, C.B., as Receiver and Accountant-General in 1882.

J. D. F. Andrews and Co.—We have received from the Woodside Electric Works, Glasgow, a copy of the electric light catalogue issued by this firm, in which is given descriptions, illustrations, and prices of the Woodside dynamos, Andrews's patent arc lamps, accumulators, incandescent lamps, fittings of various kinds for house and ship lighting, switches, measuring instruments, tools, electric light leads, belting, and other accessories. The list is in a handy form, and is well printed.

Electric Lighting Contracts.—A friend asks us if we can inform him how decisions are arrived at as to which firm, tendering for contracts, shall carry out the work. As an instance of what he considers somewhat enigmatical, he tells us that the contract for an electric lighting installation, which shall be nameless, was placed in the hands of a firm whose tender was £500 higher than that of another competitor, the total contract being less than £2,000. *Quien Sabe.*

Induction.—We are indebted to Mr. David Brooks for advanced proofs of the New York *Electrician*, in which his article on "Some Considerations Regarding Induction" first appeared.

Electrical Formulæ.—The letter which we publish on this subject from Mr. Moon is very lengthy, and we would draw the attention of our correspondents to the desirability of observing brevity in their communications, more especially when the interest in the controversy appears to be centred in the disputants only. We had thought that a more general interest would have been manifested in Mr. Andersen's papers, for his formulæ agree, we believe, with the practical results obtained by machines constructed in accordance therewith. Should Mr. Andersen deem an answer to Mr. Moon to be necessary, we will insert it, but it will then be desirable that this matter should be allowed to rest.

Overhead Wires in the States.—At Harrisburg, U.S., some of the city officials and the newspapers have recently been attacking the aerial lines, claiming that the wires must go underground. The City Council in December discussed an "ordinance" ordering all wires to be placed underground, but indefinitely postponed its decision. The superintendent of the telephone company, and a representative of the electric light company, ably addressed the council, pointing out the difficulties in the way of carrying out the proposition. The former read extracts from the report of the Brooklyn Commission, which stated that, after examining six hundred methods, the commission was of opinion that no permanent underground system had yet been discovered.

Anglo-American Telegraph Company. — Mr. S. Jackson, who spoke at the meeting of the Shareholders' Association in connection with the Anglo-American Telegraph Company reported in our last issue, asks us to correct the statement attributed to him that the original promoters of the cable received "£1,200,000 for £100,000 in twelve months." The latter figure should have been £600,000.

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Telephony in the North.—We are informed that the New Year opens with every sign of increased activity as far as the Northern District Telephone Company is concerned, and from all appearances 1886 will be a very busy time in the district, despite the depression in all branches of trade; for, after the first shock of the annual subscription is got over and the cost is reckoned up, it is generally found that the telephone, instead of proving an extra expense, becomes a source of economy. The line between Wingate Colliery and Hartlepool, a distance of about 12 miles, was opened in time for Christmas greetings and good wishes to be exchanged through it, and it is a very important piece of work, constituting as it does the first part of the trunk line between Hartlepool and Sunderland. When so much is being written and argued with regard to overhead wires and the recent snowstorms, it is satisfactory to report that in this district there has been a complete immunity from the troubles and dangers which have been so plentiful in London and other districts, and there has not been a single case reported of wires being broken by the snow or the gales in Sunderland. To anyone who knows the character of the storms experienced lately in that place, this fact speaks volumes for the excellence of the work. At the annual *soiree* of the Literary and Philosophical Society at Newcastle, the installation of telephones lent by the company proved the centre of attraction, and much surprise was caused amongst the guests at the ease with which they could listen to the concerts that were going on in various remote parts of the building; much credit is due to Mr. Dalzell, the company's inspector at Newcastle, for the success of the experiment. Owing to the increase in the number of subscribers, and the want felt for improved appliances, the company has just ordered a new multiple switch board for Sunderland, which will undoubtedly prove a great boon. The trunk line between Newcastle and Sunderland is also being strengthened with additional wires. At the annual meeting of the company in December, Mr. C. B. Clay, who, for some years past, has been well known in connection with the United Telephone Company in London, was formally appointed manager of the Northern District Telephone Company, a position he has practically held for the past six months, and the appointment of one so well known in the telephone world will undoubtedly prove a great cause for congratulation to the directors and empioyés of the company.

Overhead Wires and the Storm. — The District Manager at Nottingham of the National Telephone Company informs us that during the late snow storms, although the company has different kinds of wire, such as iron, copper and bronze, on the same poles, there was not a single breakdown recorded. One of the junction poles, 105 feet high, carries 190 wires, consisting of No. 17 copper, No. 71 covered iron and 18 G bronze. The trunk lines to Loughborough, Long Eaton and Ilkeston, and the three suburban junction lines also escaped interruption. The first named trunk loop exceeds 40 miles in length, being connected on the metallic system and passing through a well-wooded district. Thus it may be gathered that it is not impossible to construct ærial lines which shall resist any ordinary pressure of snow. This record of unbroken wires and that sent us by the Northern District Telephone Company, is exceedingly satisfactory in the face of much that is being said and written just now.

The Telephone at Nottingham.—The National Telephone Company has been gradually extending its area of operations in the Nottingham district, having recently established connection with Long Eaton, Basford, and Loughborough, and to this list Ilkeston has just been added. Placed in such a busy locality the Nottingham exchange should prove highly successful; but a query which suggests itself to us after perusal of a statement in a local paper, is, *Why* is it impossible for the National Company to accept messages from "other than its regular patrons and subscribers?" Why may not call offices be opened in Nottingham as well as elsewhere.

Aurora Borealis.—On Saturday night an unusually brilliant display of the aurora borealis was witnessed in Scotland. Immediately previous to the auroral display, the longer telegraph lines were slightly interrupted by earth currents, which reached their maximum at 6.50 p.m. At that time, from observations taken at Aberdeen, there was a south to north earth current of 28·83 milliampères, and the currents continued with varying force till 7.15 p.m.

At East Linton the first appearance was at 8 p.m. It began in the zenith, extending in beautiful coruscations from south-east to north-west, afterwards in several lovely circles in the north, lighting up the sky as at sunrise.

At Stonehaven, about 8 p.m., the aurora was very bright, shooting from the northern horizon to the zenith, whence, after describing a circle, it spread all over the heavens, and afterwards disappeared. For about an hour the telegraph wires were affected by the storm, and the electric bells at the railway signal cabins were rendered quite useless. Similar reports come from the west of Scotland.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Brighton Electric Light Company, Limited.—An agreement dated 5th inst., and filed on the 6th inst., between this Company and Frank Welden Bentley, of 4, Sydney Street, South Kensington, provides for the adoption and confirmation by the company of the agreement dated 1st ult., for the purchase of the goodwill of the business of Mr. Robert Hammond, at Brighton, and Mr. Bentley is indemnified from all liability in acting as trustee for the company, in connection with the said agreement.

Consolidated Electric Company, Limited. — The annual return of this company made up to the 12th June, 1884, was filed on the 11th inst. The nominal capital is £100,000 in £1 shares, the whole of which are taken up and are fully paid.

Gülcher Electric Light and Power Company, Limited.—The registered office of this company is now situate at the Battersea Foundry, Wellington Road, Battersea.

CITY NOTES, REPORTS, MEETINGS, &c.

The Western and Brazilian Telegraph Company, Limited.

THE report of the directors for the year ended 30th September, 1885, states that the total earnings amount to £127,396 9s. 5d., an increase of £21,222 1s. 1d. compared with last year.

The working expenses for the year, exclusive of renewals of cable, amount to £60,155 19s. 4d. as against £61,871 5s. 2d., a decrease of £1,715 6s. 10d.

The company has had to replace by sheathed cable during the year 156 miles of the old unsuitable type of cable; the amount thus expended, £15,175 10s. 6d., has been charged to the renewal fund.

Including the amount brought forward from 1884, the balance to the credit of the revenue account is £42,296 17s. 9d., of which £10,000 has been placed to the renewal fund, leaving £32,296 17s. 9d., from which the directors recommend the payment of a dividend of 2½ per cent. free of income tax, leaving £3,459 0s. 3d. to be carried forward. This will give to the preferred ordinary shares 5 per cent. for the year and one-half per cent. on account of the year ending 30th September, 1884.

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The directors would have been enabled to recommend the payment of a larger dividend to the shareholders, but for the loss on exchange which has continued to increase, and amounted during the year to £10,648 6s. 3d.

In order to place the system between Pernambuco and Rio de Janeiro in perfect order, by the immediate removal of the remaining old strand type, which had become faulty, the directors invited tenders for the manufacture of 200 miles of sheathed cable. The company's ss. *Norseman* was ordered home to carry this cable to Brazil, and has now arrived out on the coast. During her absence the duty was provided for by placing the *Viking* in the centre of the system to be ready for any emergency.

The directors again draw attention to the extensive renewal of the old strand type of cable during the year; the steps now taken will complete the removal of this faulty type from the main revenue earning sections of the company.

Owing to pressing competition efficient and speedy repairs have been absolutely necessary in order to keep the traffic over the company's line. The remaining mileage of the strand type will now be reduced to 226 miles between Ceara and Pernambuco, and there is therefore a near prospect of reducing the heavy expenses caused by the maintenance of repairing ships, by re-arrangements rendered practicable owing to the permanent improvement effected in the company's system.

It may be as well to remind the shareholders that under many difficulties, no less than about 2,300 miles of solid sheathed cable have been substituted for the old unsuitable strand type.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended 31st December, 1885, contains the usual statements of account for the half-year, which shows that the revenue, after deducting out-payments, amounted to £38,115 3s. 5d. against £68,824 5s. 2d. (after similar deductions) for the corresponding half-year of 1884: being a difference of £30,709 1s. 9d. against the half-year under review, owing to the operation of reduced tariff and competition.

The working and other expenses for the same period, including income tax, &c., but exclusive of cost of repairs of cables, amounted to £16,631 13s. 0d, leaving a balance of £21,483 10s. 5d. as the net profit of the half-year, making, with £10,733 14s. 7d. brought forward from the previous half-year, a total balance of £32,217 5s. 0d. For the corresponding half-year of 1884 the working expenses and other payments, exclusive of debenture interest, amounted to £16,857 15s. 0d.

Interim dividends of ¾ per cent. each, for the quarter ending 30th September, 1885, paid 24th October, 1885, and for the quarter ending 31st December, 1885, payable 23rd January, 1886, together amounting to £18,213, have been declared.

The sum of £8,037 3s. 9d. has been set aside to the reserve fund, thereby increasing that fund to £320,000, leaving a balance on the revenue account of £5,967 1s. 3d., which has been carried forward.

The interruption in the short section of cable, mentioned in the last report, was repaired on the 27th August.

A break occurred in the main section on 4th September last, and was promptly repaired on the 7th of the same month. The cost of the above repairs, £3,362 12s., has been charged against the reserve fund.

With a view of affording additional facilities to the public joint offices have been established by the associated companies at Glasgow, Bristol, and Havre.

Eastern Telegraph Company, Limited.

THE revenue of the company for the half year ended September 30th was £331,420, the available balance being £194,107. Interest on debentures and debenture stocks absorbed £27,260, the interest on the preference shares took £20,297, and the two interim dividends of 1¼ per cent. each, with a bonus of 1s. per share, or ½ per cent. on the ordinary shares, took £114,000, a balance of £32,549 being carried forward. In August last an International Telegraph Conference was held in Berlin, to which the English companies were invited to send representatives. Important questions were discussed affecting the interests of the companies, and a proposal urged by the Indian Government to reduce the rate between England and India was agreed to. Important reductions in the European tariffs were also voted by the conference. It is estimated that these alterations will affect the company's revenue to the extent of £40,000 a year, but the directors trust that with the growth of traffic resulting from reduced rates the loss will be gradually diminished. Her Majesty's Government having invited tenders for establishing submarine telegraphic communication between St. Vincent (Cape de Verd) and the British possessions on the West Coast of Africa, this company and the Brazilian Submarine Telegraph Company joined in sending proposals which have been accepted, under which a subsidy of £19,000 a year for 20 years is granted by the Government in respect of a cable from St. Vincent to Bathurst, Sierra Leone, and other British possessions southward to the mouth of the Niger. A separate company called the African Direct Telegraph Company has been formed to carry out this project, and the directors, with a view to the additional traffic which will be brought over to this company's lines, and the strengthening of its interests in Africa, have agreed, subject to the approval of the shareholders, to provide one-third of the capital required. As the larger part of such capital will be raised by debentures of the African Direct Company, it is estimated that this company's proportion of the balance to be issued in shares will not exceed £75,000, which the directors propose should be subscribed and paid for by the issue of a sufficient amount of this company's 4 per cent. debenture stock, which is now at or above par. The arrangements with the Governments concerned are not yet completed, but further explanations on the subject will be given at the meeting.

Hammond Electric Light and Power Supply Company, Limited.—Mr. William Theobald, F.C.A., liquidator of this company, has given notice that he is prepared to pay the debenture-holders upon application at the offices of Theobald Brothers and Miall, 23, St. Swithin's Lane, E.C.

The Direct United States Cable Company, Limited.—The Board has resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum for the quarter ending 31st December, 1885; such dividend to be payable on and after the 23rd inst.

International Electric Company, Limited.—At a general meeting of this company, held on Wednesday, resolutions for the voluntary winding up of the company were confirmed, and Mr. Ernest Cooper, of the firm of Cooper Brothers & Co., of George Street, Mansion House, was appointed liquidator.

The West Coast of America Telegraph Company, Limited.—The directors of this company have declared a dividend for the past half year of 3s. per share.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st December are £2,017, as compared with £2,359 in the corresponding period of 1884. The September receipts, estimated at £3,876, realised £3,913.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 8th were £2,336, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending December 31st were £3,825.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended January 8th were £3,091.

NEW PATENTS—1886.

251. "Method of generating electricity." S. VYLE. Dated January 6.

281. "Galvanic batteries, &c." J. HOSKING. Dated January 7.

283. "Electro-mechanical governor." O. E. WOODHOUSE, F. L. RAWSON. Dated January 7.

290. "Elements of primary batteries." H. WOODWARD. Dated January 7.

299. "Electric indicators for house bells." J. C. REVILL. Dated January 8.

311. "Telephones." R. H. RIDOUT. Dated January 8.

321. "Electric battery." G. J. ATKINS. Dated January 8.

335. "Voltaic batteries." D. G. FITZ-GERALD. Dated January 8.

337. "Electrical transmission of sound." W. R. LAKE. (Communicated by J. W. Bonta.) Dated January 8. (*Complete.*)

355. "Electric measuring instruments." S. EVERSHEAD. Dated January 9.

398. "Method of supplying liquids and mixtures to electrical batteries." J. T. ARMSTRONG. Dated January 9.

409. "Street curb for receiving electric wires." W. REDDALL. Dated January 9.

450. "Electric lamps." B. J. B. MILLS. (Communicated by A. Million.) Dated January 11.

469. "Electric lights and apparatus for illuminating by electricity." A. C. FERGUSON. Dated January 12.

483. "Elements for primary batteries." H. WOODWARD, E. M. GREGORY. Dated January 12.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

2117. "Improvements in electric telephony." J. G. LORRAIN. Dated February 16. 6d. The inventor employs an apparatus consisting of or comprising in its simplest form a disc, plate, or other shaped mass of conducting material capable of movement as a whole, or of movement, bending or vibration in part—like a diaphragm, for example. From the centre, or any convenient part of the said disc, plate, or other shaped mass, hereinafter called the plate, a point, also of conducting material, projects. Opposite this point, and in close proximity thereto, is placed a

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suitable conductor, of any desired shape, which is hereinafter called the knob. Either the plate or the knob may be in electrical connection with the line or with earth. This apparatus may act both as transmitter and as receiver.

2162. "An electric light switch." A. P. LUNDBERG. Dated February 17. 8d. Relates to an improved switch of the description already described in the REVIEW.

2165. "Certain improvements in the construction of electrical batteries." J. T. ARMSTRONG. Dated February 17. 8d. The outer part of the battery (that is the part now understood as the box or chamber part) is made in sections with flanges and then the said sections are joined together with screws and nuts, or in any other suitable manner; these sections have flanges made of ebonite, earthenware, glass, insulated wood, or other suitable material. The joints are made tight with asbestos, putty, rubber, or other substance that may be found to answer the purpose of making a tight and lasting joint.

2287. "Improved electrical accumulators or storage cells." T. S. SARNEY and A. S. HAMAND. Dated February 19. 6d. In carrying the invention into effect the plates are formed with a thick rib of the metal of which they are composed, situated horizontally across their surfaces and by preference about the centre. To the ends of these ribs are attached stout strips of metal leading through the electrolyte to the connections with the main conductors of the accumulator. The plate in this shape is now completely surrounded with the porous mixture, the whole mass slightly pressed into a uniform shape in a mould, the plate and its porous covering being then bound round with suitable material and finally being covered with stout unglazed paper, placed in a proper oven to evaporate all moisture.

2395. "Improvements in resistance boxes and similar apparatus for use with incandescent electric lamps and for other purposes." G. A. NUSSBAUM. Dated February 21. 8d. The inventor employs a substance having a composition corresponding more or less with that of the black lead ordinarily used in black lead pencils, and consisting mainly of a mixture of plumbago or graphite and clay. These materials are prepared, mixed, and moulded into rods, pencils, blocks or other desired form for use as resistances, in a similar manner to that adopted for the manufacture of black lead.

2747. "The construction of storage or secondary batteries or electric accumulators." W. SYMONS. Dated March 2. 4d. The batteries are made chiefly or entirely of carbon in plates, rods, or cylinders, in which cavities or spaces are made for containing oxide of lead or other suitable material.

2795. "Improvements in secondary batteries." H. J. ALLISON. (Communicated from abroad by P. Benjamin, of America.) Dated March 3. 6d. The liquid employed is prepared by adding to a zinc sulphate solution magnesium oxide in such quantity as will be sufficient to neutralise the sulphuric acid set free when the zinc sulphate solution is decomposed on the charging of the cell. The anode of the cell is preferably made in the following manner. The material of which it is to be composed, such, for example, as lead or an alloy of lead with a non-oxidisable metal such as antimony or bismuth, is melted and then cooled until it becomes plastic. While thus plastic it is stirred until it assumes a finely-divided condition and shows a tendency to solidify. The mass is finally allowed to cool in a mould when the small particles of which it is composed cohere at their points of contact, thus rendering the electrode very porous, causing it to expose a large active surface, and thus greatly saving time in the formation of the plate.

3353. "Improvements in apparatus for opening electric circuits to prevent damage, applicable especially to the derived circuits in which incandescent lamps are placed." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. To open a derived circuit in which are incandescent lamps; in order to protect this circuit from destruction in the event of short circuiting, an apparatus is employed consisting of attachments, each having a clamping screw and each being fixed to an insulating board; they receive the wires of the main circuit. The current passes from one attachment to a spring and on the end of the spring is a hook which engages with another similar hook on another spring. Through this spring the current passes to an electro-magnet from which a circuit wire is led to one or more incandescent lamps, whence it passes to, and is connected with an attachment clip on the main lead. On one of the springs an iron piece is attached serving as an armature to the electro-magnet, but it is kept remote therefrom by the elasticity of the spring. The electro-magnet is adjustable and may be moved nearer to or farther from its armature to regulate the safety apparatus and set it to be operated by a larger or smaller current as may be required, due consideration being had to the maximum current which the derived circuit can pass without danger to the circuit or the lamps. If this maximum is exceeded, owing to short circuiting or other cause, the electro-magnet by its attraction moves its armature, whereby the springs become detached from one another, an interruption thus occurs and destruction is obviated.

3358. "Improvements in and relating to electro-dynamic motors and dynamo-electric generators." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated March 14. 1s. 1d. The main feature of the invention is the use of a continuous field circuit wound sectionally in layers, the coils of each section of a series being wound upon the whole length of the core or of that portion of the core which is enclosed by the series, and the sections are connected together so as to form a continuous and unbroken series of coils. Connections from the bights of these coils are brought to suitable contact blocks on which travel arms which form the inlet and exit terminals of the supplying circuit. Means are provided for changing the connection of the terminals of the supplying circuit from one part of such field circuit to another, whereby the effective magnetic moment of such field coils is varied in any desired progression and direction.

3798. "Improvements in electric batteries." W. R. LAKE. (Communicated from abroad by H. L. Brevoort and I. L. Roberts, of America.) Dated March 24. 8d. Consists in a battery carbon and a reservoir or liquid holder arranged at the upper portion of said carbon, and communicating with the pores or interstices of the carbon, so that liquid will be supplied from it to the carbon and will percolate thence towards liquid in the cell of the battery.

5758. "Improvements in casing for carrying under foot telegraph, telephone, and other wires, pipes, or tubes." H. O. ADAMS. Dated May 11. 8d. Consists in constructing the curbs of street and other pavements or paths of a hollow section or sections so as to contain and carry therein wires, tubes, or pipes used for telegraph, telephone, or other purposes.

6878. "Improvements in the construction and arrangement of electrical batteries, and in devices or contrivances to allow of the emptying or withdrawal from, and the re-charging of, such batteries with the exciting fluids." J. T. ARMSTRONG. Dated June 5. 8d. Consists in improvements on the invention described in Patent No. 2165, 1885.

9570. "Improvements in the apparatus used for generating currents of voltaic electricity, the improvements being applicable to electric table lamps and general domestic electric light and power." R. H. COURTENAY. Dated August 11. 11d. The inventor constructs the inner cells with substances of different degrees of porosity, one side being carbon, which becomes the substitute for the ordinary carbon plate, the other side being preferably unglazed earthenware, or other substances of a porous nature can be used.

12205. "Regulating apparatus for arc electric lamps." C. DORNFELD. Dated October 13. 6d. Relates to an improved construction of electric arc lamps, wherein the distance of the carbon points is regulated by means of mechanism consisting of a rack and pinions, an escapement wheel and its anchor, and an electro-magnet in a shunt circuit.

12851. "Improvements in conduits for electric wires and cables, and for other purposes." G. D. SUTTON. Dated October 27. 8d. Relates to conduits for electric wires and cables, and for other purposes; and it has for its object the furnishing of a practicable method of laying electric wires and cables beneath the surface of the ground, without materially interfering with the paving of the carriage ways or side walks of cities.

12932. "Improvements in electric gas lighting burners." A. J. BOULT. (Communicated from abroad by D. Rousseau, of America.) Dated October 27. 8d. This invention applies to that class of burners in which the movement of a lever pivoted on the burners operates the gas valve to turn on the gas, and simultaneously actuates the electrodes to produce the igniting spark. In most all burners of this type the valve is a rotary friction plug of the common form, and is revolved by a ratchet movement of the lever. In this present invention the burner is provided with a minute double seating poppet valve, which works without packing or friction in a direction across the gas passage of the burner, and the usual ratchet and cam wheel between the valve lever and the pawl lever or sparking lever is dispensed with entirely, and a direct engagement is formed between the valve lever and sparking lever, so that the forward movement of the lever opens the valve and produces the igniting spark, whereas the back movement of the lever positively closes the valve.

13109. "Improvements relating to arrangements or systems of underground electrical conductors, and to apparatus for use in connection therewith." W. R. LAKE. (Communicated from abroad by D. H. Dorsett, of Chicago.) Dated October 30. 8d. This invention is an improvement in systems of underground electrical conductors, the improvement being directed to facilitating the laying and distribution of the conductors throughout a city, or any part of the same; to the better insulation of said conductors, and the prevention of inductive or other injurious effects arising from the close proximity of circuits for different purposes, such as telegraphing or telephoning on the one hand, and electric lighting on the other.

13453. "Improvements in electric clocks." E. G. COLTON. (Communicated from abroad by F. Haenichen, O. Haenichen, and O. Sebass, all of New York.) Dated November 6. 8d. Relates to an improved electric clock which can be run for a considerable time without recharging the battery, and in which the contact points are exposed to little wear by oxidation, owing to the complete neutralisation of the residual magnetism in the cores of the actuating electro-magnet and the prevention of induced currents; and the invention consists of an electric clock, the pendulum of which receives impulses from a crutch oscillated by a lever attached to the armature of an electro-magnet. The lever actuates the hands of the clock by intermediate gearing. The residual

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magnetism in the cores is neutralised by sending a current in reverse direction through the coils of the electro-magnets, which is accomplished by suitable circuit closing and reversing devices and a disconnector operated by the armature of the electro-magnet.

13668. "Improvements in telegraphic instruments." G. W. STEWART. Dated November 10. 8d. The invention consists in part of a telegraphic instrument or sounder comprising a pivoted bar connected to the armature of an electro-magnet or magnets, and carrying a pointed projection through which a message can be received by the sense of touch alone, the vibrations of the armature being communicated through the pivoted bar and its pointed projection to the finger of the operator.

CORRESPONDENCE.

Re Electrical Formulæ.

There are some people who, rather than admit that they are wrong, will revert to the most pitiful prevarication, and the final subterfuge of such people is, frequently, the use of a burlesque style of argument. I am sorry that Mr. Andersen has thought fit to adopt such a method of arguing.

This argument, first begun upon magneto machines, has been since led away from that subject and other matters introduced, until, in the last number, no mention whatever is made of the original subject; but Mr. Andersen has taken each of my last remarks seriatim, and has asked me to explain them at a length which is quite incompatible with the space of the ELECTRICAL REVIEW at my disposal. I will, however, humour him as far as the small importance of the subject will permit me.

Mr. Andersen says: "The formulæ in my (Mr. Andersen's) paper having been established by ordinary algebraical reasoning, I will now ask Mr. Moon to, in a similar way, prove that any one of them is wrong, or that something contrary is correct. For if formulæ IV., VI., and VIII., in my paper are correct, then it is a physical impossibility that a case such as the one Mr. Moon alludes to can exist." But it is impossible to establish by algebraical reasoning the correctness of the connection between a formula and its physical attributes. When mathematics are used in physical research an equational expression is assumed to represent the relation between each of the factors of a problem, then by equational transpositions, the relation between one, or several, of the factors and the remainder is determined. But although such algebraical manipulations may have been performed without mistakes (as Mr. Andersen has seemingly done) the resultant formula would, of course, be inexpressive and useless if the fundamental assumptions did not clearly express the problem; consequently it is absurd for Mr. Andersen to say his formulæ have been established by ordinary algebraical reasoning. Moreover, it is impossible, in any algebraical formula, to express the whole of the relations of the factors of a physical phenomena, some we are not cognisant of, others must perforce be left to be assumed; we can only hope to express in the formula as much as is relevant to the argument, leaving out that which will be tacitly assumed. My objections to Mr. Andersen's formulæ are that they do not express the whole of the facts necessary to the argument; that they are not arranged to show clearly the relation of the factors; and that they are not even accompanied by an intelligibly worded explanation of the restricted circumstances under which they must be taken to apply. He has not, moreover, rightly interpreted the meaning of his own formulæ, and by giving formulæ for general use which are really applicable only to particular cases, he has robbed them of the little merit which was inherent in them.

I have nowhere suggested that Mr. Andersen had made mistakes in his algebraical manipulation, consequently his invitation to me to prove such errors, or as he puts it, "to shake an $\frac{a}{b} = c$," is out of place.

On pages 466 and 507 I have fully explained my objections to Mr. Andersen's formulæ, and have endeavoured to show him that when he treats of the *power and efficiency* of a dynamo, he can most clearly treat of the properties of each while the other is constant. But Mr. Andersen has slurred over, or wholly ignored these objections, and, for the sake of disputation, has entered at length upon merely incidental matter, and now it pleases him to allege that I have made loose assertions unaccompanied by facts or proofs. This is not true, since all my assertions have been accompanied by illustrative remarks which were quite adequate to the argument. It is evident that in Mr. Andersen I have to deal with one of those who, having advanced erroneous rules, refuse to see the arguments by which they are refuted.

Here is an instance of Mr. Andersen's inconsistency. He objects to my saying, "It is useless for Mr. Andersen to plead that his formulæ are for use *only* in the construction of dynamos," and then immediately afterwards says the statement, "From the preceding it is obvious that Mr. Andersen then proposed to use this particular quality of dynamos as a general criterion by which the values, *in regard to electro-magnet construction*, of machines of different types might be determined" is fairly correct. But judging by Mr. Andersen's succeeding remark, it would appear that even he is awaking to the fact that his term, "figure of merit," cannot be pandemic in its applications.

Referring, now, to Mr. Andersen's formula on page 431. Taking

$$\text{activity, } W = E\,C = F\,V\,L\,s\,a \qquad \text{IV.}$$

and

$$\text{electrical efficiency} = 1 - \frac{w\,a}{W} \qquad \text{V.}$$

by the usual substitutions he obtains

$$\text{electrical efficiency} = 1 - \frac{a\,\kappa}{F\,V} \qquad \text{VI.}$$

and then he says of IV. and VI., "so the percentage of internal waste is inversely proportional to F, while the activity is directly proportional to F." Whence Mr. Andersen concludes that F is a true expression for the merit of the machine. But why F more than V, which is similarly situated in Mr. Andersen's formula? Because (says Mr. Andersen) the velocity may be eliminated as a mere mechanical condition. But when we consider that the linear velocity of some machines is as much as three or four times that of others, it becomes evident that there are some electricians who do not agree with Mr. Andersen, that "the velocity is a mere mechanical condition." However, I hesitate to advance this as an argument, lest Mr. Andersen should avail himself of it as a bypath by which he may diverge from the main arguments.

I will now proceed to answer, in a convenient order, the questions Mr. Andersen has put to me. Referring again to the formula

$$1 - \frac{a\,\kappa}{F\,V} \qquad \text{VI.}$$

since

$$a \propto \frac{C\,L}{\text{size of field}}$$

therefore VI. may be expressed as

$$1 - \frac{\kappa_1\,C\,L}{F\,(\text{size of field})\,V}$$

Here "F" and "(size of field)" are similarly situated and, consequently, are of equal importance. To make an efficient machine we must not confine ourselves to making either "F" or "(the size of field)" a maximum, but *we must adjust the effective strength of the field to its size so as to make their product a maximum.*

This product, I opine, is the "figure of merit" which Mr. Andersen has been seeking, but which he has failed to discover. That he does not understand clearly the relation between "F" and the "(size of the field)"

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is proved, I think, by his formula $\frac{a\,\kappa}{p\,F\,V}$ on page 447. In this example Mr. Andersen proposes to increase the volume of the armature in the reciprocal proportion to the strength of the field. But this is not possible, since below the maximum value of the product

(size of field) × (strength of field),

the size of the field would of course decrease more rapidly than its strength would increase.

The importance of the other factors of the efficiency of the dynamo would not justify us in using either the size, or the strength of the field, or their product, as the only criterion of the value of the machine. For referring to the last formula more correctly expressed we have

$$\text{elec. efficiency} = 1 - \frac{\kappa_1\,C \qquad L}{F\,(\text{size of field})\ \text{function of}\ V}$$

Whence it will be seen that to make the machine most efficient it is now necessary to keep $\frac{\kappa_1\,C}{F\,(\text{size of field})}$ constant, while V and L are so adjusted as to make the quotient of $\frac{L}{\text{function } V}$ a minimum.

In my last communication I said that Mr. Andersen's expression $F\,\frac{w\,a}{w\,a + w\,m}$ would be a maximum with a small armature moving in a strong magnetic-field and performing little or no external work. This I thought evident enough without any further example or explanation; since the nearer the pole pieces are brought together the stronger the magnetic-field, *i.e.* "F," becomes; also since the size of the field becomes smaller $w\,a$ becomes greater, until at last $F\,\frac{w\,a}{w\,a + w\,m}$ becomes a maximum when the size of the field is such that the armature is just large enough to keep the field-magnet excited, without performing any external work. Hence in this case the "figure of merit" is increased by making the machine less efficient and less economical.

I might also remark of this formula $F\,\frac{w\,a}{w\,a + w\,m}$ that, on page 447 after Mr. Andersen had shown that in a particular case and under restricted circumstances a dynamo had an internal waste of $\frac{w\,a + w\,m}{w\,a}$ that of a magnetic machine, he thence concluded that the coefficient $\frac{w\,a}{w\,a + w\,m}$ could be applied to all cases without being qualified by any limitating data; consequently he has introduced the absurdity that I have previously explained.

Mr. Andersen says: "that the hope for efficiency of those recent machines which rely upon a weaker field and a comparatively large armature, is built upon sand." Mr. Andersen's opinion, possibly, may interest the designers of those machines more than myself. I need only here remind Mr. Andersen that they were designed by men of repute.

In my last communication I pointed out that machines must perform work all the same while their comparative values are being determined. Obviously, if we wish to compare the values of machines of different types we can most fairly do so by comparing machines of each type of equal power. But since it is frequently not possible to do this, the more general methods are to compare their values when the machines perform work at a rate proportional to their whole mass, or to the mass of their armature, or to their cost. Mr. Andersen prefers comparing the machines when they perform work at a standard maximum safe temperature; but this temperature would differ in different machines and would be difficult to determine; it would not, moreover, be always the most economical rate at which to work the machines.

Since Mr. Andersen calls upon me to explain so simple a thing as the difference between the sensibility and efficiency of telegraph instruments, I will define them as follows:—

The sensibility is proportional to the reciprocal of the current required; the efficiency and economic value are functions of the rate at which work is expended in the coils.

From his last remark it would appear that Mr. Andersen has yet to learn that matter and force are of equal importance in the economy of nature.

In conclusion, I can only express my regret of the manner in which Mr. Andersen has treated my friendly and just criticism, and hope that in continuing the discussion he will exhibit a better spirit.

W. Moon.

Galvanic Batteries.

Permit me to point out that it is inaccurate to say that my bichromate battery resembles that of Fuller except in employing more sulphuric acid, as stated in a note in your last issue.

Fuller's patent mercury bichromate battery has the zinc rod completely immersed in mercury which fills the porous pot.

A bichromate battery, similar to that now called Fuller's, was submitted to Mr. R. S. Culley, late Engineer to the Postal Telegraphs, by Mr. Lumsden and myself in the year 1869.

F. Higgins.

January 7th, 1886.

[Our correspondent is mistaken with reference to the Fuller battery. A small quantity of mercury (2 oz.) only is placed in the porous pot, this amount covers the lower part of the zinc rod to the height of about $\frac{1}{16}$th of an inch only, and the mercury amalgamates the rest of the zinc by creeping up it.—EDS. ELEC. REV.]

The Brake H.P. of Gas Engines.

As you have expressed a desire that I should furnish you with particulars of how I tested the brake H.P. of my ½ H.P. Otto engine, as the result appeared unprecedented, I have pleasure in giving you the particulars. The flywheel is 3 feet 6 inches diameter, consequently 10·9956 feet in circumference, say 11 feet. The speed I run the engine at is 196 revolutions per minute, hence the feet velocity of the periphery of the flywheel per minute is 2,156. At this speed a total weight of 18½ lbs. attached to a belt, the latter being thrown over the flywheel, is kept suspended, equal to 39,886 foot pounds, which represents a little over 1·2 H.P., being the power I stated in my former letter. I tested the engine again on Saturday night, after it had been running for six hours, with the foregoing result. I do not think this is unusual with the ½ H.P. engines made by Messrs. Crossley during the last two years, as I understand the cylinder is of wider bore than formerly.

J. H. Greenhill.

Belfast, *January 11th*, 1886.

Correction.

Kindly allow me space in the next edition of your valued REVIEW for pointing out that the following sentence in my paper, "The application of springs to polarised telegraph instruments," page 31, 11th line from top (the REVIEW of 8th January):—

"In the former instance (Siemens's relay), and in the latter, &c.," of course, is incorrect.

The sentence should read thus:—

"In the former instance (Siemens's relay), *but not* in the latter, &c."

K. Gulstad.

Copenhagen, *January 11th*, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 426.

THE TRAMWAY TRACTION OF THE FUTURE.

ONE of the most important papers bearing upon the practical applications of electricity which has ever been compiled is that which Captain Douglas Galton, F.R.S., read before the meeting of the Society of Arts on Wednesday evening last. To the advocates of electrical propulsion for tramcars, and we must include ourselves amongst its warmest supporters, the facts contained therein must be welcome indeed, and the author's name is a sufficient guarantee of their veracity, for Captain Galton is not the kind of man to be led astray by enthusiasm over a novelty or by a partiality to any particular means of arriving at an end. For several years past experiments, duly recorded in the REVIEW, have been made intermittently in different directions with tramcars for which the motive power has been electrical energy, applied in a variety of ways. Three or more tram lines have now indeed their cars regularly run by electrical means. Two of these, however, are happily placed in localities where water-power is plentiful and readily available, and we have therefore but meagre information respecting the details of working such lines in large towns where it would be necessary to employ steam engines, dynamos, and accumulators, and erect charging stations. On the whole, then, it could scarcely be expected that much enterprise would be forthcoming towards supporting an undertaking which should revolutionise our present methods of locomotion and of which so little was definitely known. In America and on the Continent things are ordered differently; new ideas are made to rapidly develop, they are then commercially treated and the results soon spread abroad. If successful, we begin to think that it is time we took advantage of the outcome of foreign capital and enterprise, and we slowly commence to imitate that which we could and ought in nine cases out of ten to initiate.

We will not, however, moralise upon that which is apparently inherent in the British character, and therefore presumably unalterable, but return to the paper upon which we base our remarks.

Our readers are doubtless aware that an interesting feature in the late International Exhibition at Antwerp was the competition between different forms of mechanical motors on tramways for use in towns.

In this country the development of tramway lines has been very great, and in populous districts these supply a want which light railways, even if constructed, could never properly fill. Tramways, to satisfactorily fulfil their functions, must be operated by mechanical traction, and the motor which is found most adaptable will eventually come to the fore.

The competitions between different forms of motors at the Antwerp Exhibition was carefully superintended, and their qualities and defects ascertained; this at least affords a starting point from which it will be possible to carry on further investigations.

The experiments were made on a specially constructed line ending in a triangle of 505 metres, thus enabling those motors which did not reverse to run in the same direction. Of the total length, viz., 2,797 metres, 2,295 metres were in a straight line, 189 metres in curves of 1¾ chains radius, and 313 metres in curves of 1 chain radius. There were four passing places, exclusive of the terminus, and these were joined to the main line by curves having a radius of 1¾ chains. The track was practically level, the locality affording no opportunity for obtaining a line with steep gradients.

The experiments lasted four months, and there were five competitors. Of these, three systems were based on the direct action of steam:—the Krauss locomotive, separate from the carriage; the Wilkinson locomotive, also separate; and the Rowan engine and carriage combined. The fourth was the Beaumont compressed-air engine; and the last, but as will be seen not least, a single electrical car.

It is not our intention to describe the four first-mentioned methods, but the details of the electrically propelled car may be found in our other columns.

A regular service was established according to a fixed time table, to which each motor was required to conform. Each journey was reckoned as starting from the end near the Exhibition proceeding to the beginning of the triangle and returning to the starting point. An hour was allowed between the commencement of each journey, 14 minutes were allowed for a stoppage at the end near the Exhibition, and 18 minutes at the other end—thus allowing 28 minutes for travelling 2 miles 1,500 yards, a speed of about 6 miles an hour. The motors were required to work four days out of six, and on one of the four days to draw a supplementary carriage.

An official, assisted by a storekeeper, was appointed to keep a detailed record:—

1. Of the work done by each of the motors.
2. Of any delays occurring on the journey, and of the cause.
3. Of the consumption of fuel, both for lighting the fires and for working.
4. Of the consumption of grease.
5. Of the consumption of water.
6. Of all repairs of whatever nature.
7. Of the frequency of cleaning and other necessary operations required for the efficient service of the motor.

From the foregoing, and from the further details given on other pages, it will be seen that the tests were of a very prolonged, definite, and exhaustive nature, and the result speaks volumes for the electrical system, notwithstanding the car gearing, which cannot meet with approval. Although Captain Galton's conclusions are generally in favour of electrical propulsion, he is

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careful to point out several matters on which he thinks we have not yet obtained sufficiently reliable data.

It is not a little curious that while in the body of his paper he speaks of the accumulators as having the prospect of lasting indefinitely, he should be so dubious as to their durability in his concluding remarks. There is without doubt some degree of uncertainty respecting the "life" of a secondary battery; but if, as we believe, they can be depended upon in electric lighting for a matter of two years, we think they could readily be constructed to remain in workable condition for at least half this period, which would be, commercially speaking and from an economical point of view, long enough for tramcar purposes.

The economy of the system, favourable as it appears even now, might readily be improved. A more efficient charging dynamo could easily be obtained, and the steam engine used, as Captain Galton implies, might easily have been a better one.

Apropos of this dynamo, we are told it delivers a current of 20 ampères at 90 volts; that the process of charging the accumulators occupied 12 hours with a current of 13 ampères, and that the intensity varied between 25 and 23·5 ampères during the whole time of charging. These statements are somewhat confusing and require explanation.

That an absolutely reliable self-contained electrical car can be produced, indeed has been produced and is waiting to be utilised, we have no hesitation in saying, and we think that a great impetus will be given to this branch of applied electricity by the publication, just when most needed, of Captain Galton's able and comprehensive paper.

The managers of both the Portrush-Giant's Causeway and the Bessbrook-Newry lines, Mr. Holroyd Smith with his Blackpool venture, and Mr. Magnus Volk, with further information respecting his very successful Brighton line, would do good service by relating their latest experiences in electrical tramway work. Mr. Reckenzaun's personal narrative of his Berlin triumphs would be most welcome, and may be Mr. Elieson has some further progress to relate. Such a supplement to Captain Galton's work would be eagerly welcomed by the electrical world generally.

THE METERS OF PROFESSORS AYRTON AND PERRY.

EVERYONE who has anything to do with the running of arc or incandescent lamps, says Mr. Geo. B. Prescott, Jun., in the New York *Electrician*, realises the necessity of using some sort of current and potential indicators or measurers to insure uniform and satisfactory working. The portability and simplicity of Profs. Ayrton and Perry's voltmeters and ammeters have recommended them to practical men, and they are now extensively employed in commercial electric lighting. Although it is more or less well known that the moment of the permanent magnets in these instruments is subject to change, and that the value of their constants is thereby altered, but few of the actual users are aware of the extent of this variation. Even less known is the fact that the heating of the coils, particularly in the voltmeters, is another serious source of error, whilst the circumstance that in these meters a division of the scale near the zero end represents a much greater variation, in potential or current as the case may be, than a division near the other end, is almost entirely overlooked. It is evident that an instrument containing so many defects must be handled with judgment to obtain even approximately correct results, and to supply the necessary information on which to base such judgment is the object of this article. I should not consider it needful, however, if there was a more reliable and equally cheap and convenient substitute for these instruments on the market.

The results of careful tests of a large number of Ayrton and Perry's voltmeters and ammeters, extending over a period of nearly three years, may be summed up as follows:—

The permanent magnets gradually grow weaker, reducing the value of the constant.

The change is more rapid in new instruments than in old ones.

The change is more rapid in instruments which are used frequently than in those seldom used.

The change is modified by stronger magnets, such as dynamos.

The percentage change in the value of the constant is different in several instruments under apparently the same conditions.

The error due to heating of the coils is very noticeable in the ammeters, and seriously affects the voltmeters, increasing the value of the constant in both cases.

The difference in the value of a scale division at 0° and at 45° varies from 10 to 20 per cent. in different instruments.

For the same instrument a change in the strength of the permanent magnet does not alter the above percentage.

The information supplied by these facts leads to the conclusion that to obtain satisfactory results from these instruments the following conditions should be observed:—

Their constants should be frequently determined.

They should be calibrated at the current strength and potential at which they are to be used.

The voltmeter readings should be taken immediately after the needle comes to rest, and the circuit then broken. The readings should not be taken so frequently as to heat the coils.

Experience has shown that with wire of the size commonly used, the resistance of the voltmeters should not be less than 50 ohms for each volt to be measured. The wire in the ammeters should be sufficiently large to carry without appreciable heating at least double the current to be measured. They should be calibrated as often as once a fortnight to once in three months, according as they are new and much used or old and little used.

Selected according to the above specifications, and used with the precautions suggested, these ammeters and voltmeters may be made to yield results sufficiently reliable for most commercial work.

COMMERCIAL EFFICIENCY OF INCANDESCENT LAMPS.

MANY makers of incandescent lamps have found that their lamps, upon being measured, have given a much better efficiency (that is, much more light per horse-power) than other lamps in the market, and have used this as an advertisement of their lamp. For a long time, writes Mr. Carl Hering in the New York *Electrician*, and by many makers, this seems to have been the sole object, that is, to get as much light as possible from a given horse-power. In the tests made by the Board of Examiners at the exhibitions at Paris, Munich and Vienna, and by the first Board of Examiners at the Philadelphia Exhibition, this was the only and prin-

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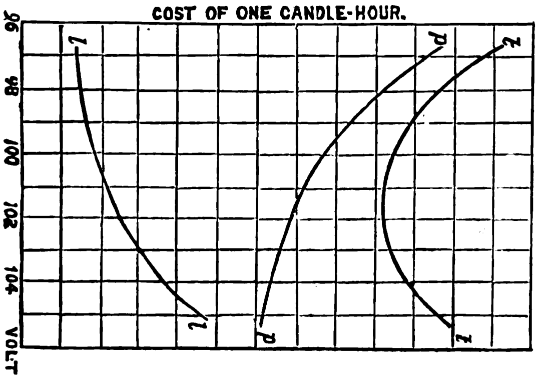
cipal measurement deemed necessary to make of incandescent lamps, and the public was left to judge from the figures obtained what the relative values of the different systems were.

In the Vienna tests, the lamps were measured with different currents, and the corresponding efficiency calculated. These values showed that the efficiency increased very fast with an increased current; in some cases even the candle-power increased with the cube of the electrical energy in the lamp. The very high efficiency of less than one watt per candle was obtained in several cases, and tended to show that these lamps were the best. In another case a lamp whose normal candle-power was only about 40 was run as high as 600 candles.

It is evident, however, to any one who has experimented intelligently with incandescent lamps, that there is another factor to be considered, namely, the life of the lamp, which, as we shall see below, sometimes has as much, and even more weight in the real commercial efficiency than the watts per candle-power. It is a well-known fact that the greater the current the better the efficiency as regards power alone, but at the same time the shorter the life of the lamps; so that many of the lamps which show such a good efficiency are really poorer lamps than those which give a less efficiency, showing that a test of efficiency by itself is of little or no value; in fact, often misleading, doing injustice to the very lamps which are really the best when the real commercial efficiency is considered, in which, of course, the life of the lamp and its cost are also main factors.

As the cost per candle-power decreases very much with an increased current, and as the life of a lamp decreases with an increased current, or what is the same thing, the cost for lamps increases with an increased current, it is evident that there is some one current or voltage at which the total cost, considering both lamps and power, is a minimum. This may be shown graphically very nicely by the adjoining diagram, taken from an excellent article on the subject by Profs. Ayrton and Perry. The abscissæ represent the potential at which the lamps were run, and the ordinates represent the cost.



The curve, *l*, *l*, represents the cost of the lamps themselves, if they are run at different potentials, or what amounts to the same thing, with different currents. This is, of course, dependent upon the life which the lamp has at those different potentials, and the cost of a single lamp. It shows that this cost increases more rapidly as the potential, and therefore the current, increases. The curve, *p*, *p*, represents the cost of the power required per candle when run at different potentials or current, and shows that it decreases rapidly at first, and less so for greater potentials. As the decrease toward the end of the latter is not as much as the increase in the first curve, it is evident that the sum of the two will fall at first, and rise again towards the end, showing that at a certain point there will be a minimum cost. This is shown by the third curve, *t*, *t*, which represents the total cost or the sum of the two others. As will be seen this becomes a minimum at a certain point, which for the particular lamp from which the data was taken, is about 102 volts, or thereabout. This, as is seen, is determined theoretically to a certain extent, while, if the writer is correct in the particular make of lamp which he assumes was used, the manufacturer found about the same result in a purely practical way by running the lamps at different potentials and finding their life, from which they determined the proper potential at which they should run their lamps.

From what was said above it is very evident that in order to determine the real relative values of different lamps to the consumer, their life and the cost of a lamp must be taken into consideration besides the efficiency. The real values of different systems of lamps to the consumer also depends greatly on the way in which the lamps and installations are made, that is whether the lamps are liable to fail at the connection between the platinum wires and the filament; what the durability of the filament is, as regards mechanical strength; the nature of the holder, that is whether the contacts between the lamp and holder are good, firm and not liable to heat; also the price and nature of holder, &c., &c. But it is evident that such factors cannot possibly be brought into any general calculation or formula, and will have to be left to the buyer to judge upon, or to an electrical engineer who is consulted.

To reduce the first mentioned qualities to a form in which different lamps may be compared, the following formula may readily be deduced :—

Let C represent the cost in cents, of one spherical candle-power per hour.
e the efficiency in watts per spherical candle-power, of the lamp at its normal candle-power.
P the price, in cents, of one electrical horse-power per hour in the lamp.
p the price of a lamp in cents.
L the life in hours, of a lamp at its normal candle-power.
c the normal spherical candle-power of a lamp.

Then the cost of one candle-power hour, as far as the efficiency is concerned, is the horse-power consumed multiplied by the price of one horse-power, that is,

$$C = \frac{e}{746} P.$$

The cost of one candle-power hour, as far as life is concerned, is the price of a lamp divided by the candle-power hours which the lamp is capable of giving, which latter is evidently the life multiplied by its spherical candle-power. This gives

$$C = \frac{p}{L \times c}.$$

The total cost in cents, of one spherical candle-power is, therefore, the sum of these two expressions, that is

$$C = \frac{e P}{746} + \frac{p}{L \times c}.$$

The only reliable data which can be used justly in making any relative comparisons of different lamps by means of this formula are the results of the excellent and thorough tests made by a special committee under the auspices of the Franklin Institute in the spring of 1885. They are the only impartial tests made of incandescent lamps of different systems which give the life and efficiency of different lamps at their normal candle-power. It is very unfortunate that one of the principal electric light companies in this country, had such a misfortune in regard to the lamps delivered to the test committee. It is very much to be regretted, as the tests of this lamp were looked upon with special interest. The results of this lamp, the Weston, in the following comparisons, cannot therefore be justly compared with the others. If, however, this company guarantees a certain life at the same efficiency obtained in the test, the comparison can be justly made with the others.

From the report of these tests, we find the average

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efficiency of the lamps of each of the different systems in watts per spherical candle-power to be as follows :—

Edison	4·459
Stanley 96 volts	4·04
Stanley 44 volts	3·544
Woodhouse & Rawson, 1st lot ...	3·605
Woodhouse & Rawson, 2nd lot ...	3·56
White	4·05
Weston 110½ volts	3·713
Weston 70 volts	4·51

In order to obtain the real average life of all the lamps used, it would have been necessary to run them all until they died, but as this was not done it will be impossible for us to get the real life from the tests. In order, therefore, to make any relative comparisons from them, it is necessary to make some assumptions in regard to the death of the surviving lamps. Although such assumptions may not be quite correct they will be at least approximately so, and will enable us to make a comparison which will, at least, give tolerably fair results.

As most of the lamps which survived have a discoloration of at least two and one-half, and many of them three to four, in a scale of six, it will not be far wrong to assume that those lamps died at the end of the test. This is a wrong assumption, but we have no right to assume a certain life for these lamps, as that would be different for different systems, nor have we a right to take only those lamps which died before the end of the test. This assumption will, however, give results which are within the limit which would be obtained if we knew the real life, that is, the real ultimate cost will not be more than the results obtained.

It will furthermore be seen from the test that the candle-power decreases very materially in most lamps, and by taking the efficiency at the beginning of the test, the error may be left to compensate, to a certain extent, the incorrect assumption that they died at the end of the test. At all events it will not be giving any lamp any undue credit to make the first assumption, and if with the final results it is remembered that a certain number survived and would have increased the life accordingly, and therefore decreased the ultimate cost slightly, it will enable one to make at least a rough comparison of the different systems. Although the results obtained thus give only rough values, it is easily seen that unless some such assumption were made, no relative results could be obtained from the tests.

Making this assumption, the average life of each of the different systems of lamps are as follows :—

Edison	1,026 hours.
Stanley 96 volts	430 „
Stanley 44 volts	293 „
Woodhouse & Rawson, 1st lot ...	290 „
Woodhouse & Rawson, 2nd lot ...	267 „
White	273 „
Weston 110½ volts	507 „
Weston 70 volts	461 „

Another assumption can be made, which may be nearer the real result, though at the same time it may give undue credit to some of the systems. At the end of the test the lamps were examined in regard to their discolouration and marked with a scale of six units, of which number six was quite dark, totally unfitting the lamp for use if it was burning. To assume, therefore, that a lamp with a discolouration of five was practically dead will not be very incorrect. It is also quite fair to suppose that the discolouration increases directly as the number of hours which the lamp burns. From this it can readily be calculated from the data of the tests at what age the survived lamps would have had a discolouration of five on the adopted scale of six units, and to consider the lamp practically dead then.

Making this assumption and calculation the average life of all the lamps of each system gives :—

Edison	2,038 hours.
Stanley 96 volts	501 „
Stanley 44 volts	319 „
Woodhouse & Rawson, 2nd lot...	305 „
White	407 „
Weston 110½ volts	1,022 „
Weston 70 volts	1,012 „

The price of a lamp to a consumer of a 100-light plant, given to the writer by the different companies, is as follows :—

Edison	85 cents.
Stanley 96 volts	70 to 75 „
Stanley 44 volts	70 to 75 „
Woodhouse & Rawson... ...	120 „
White	100 „
Weston 110½ volts	85 „
Weston 70 volts	85 „

The Stanley Company not having been heard from, the price of that lamp was taken as given by the Van Depoele Company, who use that lamp. They gave the price for a 100 volt lamp ; the writer assumed the same price for the 44 volt lamp. As the writer could not find out the cost of the Woodhouse & Rawson lamp, the price assumed was that at which the lamps were offered in large quantities to the writer, in London, about a year ago, namely, five shillings, their great efficiency being offered by the makers as an explanation for their high price.

Assume the cost of a mechanical horse-power per hour as applied to the pulley of a dynamo, including coal, attendance, shafting, &c., to be four cents, and that the commercial efficiency of the dynamo (that is, the ratio of the electrical power in the external circuit to the mechanical power applied at the belt) is 88 per cent., and that five per cent. is lost in the leads. This makes the cost in cents of an electrical horse-power in the lamp,

$$P = \frac{4}{\cdot 88 \times \cdot 95} = 4{\cdot}8 \text{ cents.}$$

Introducing all these values together with those given above into our equations, calculating the cost of the power from the efficiency in watts per candle-power, and the cost due to the life from each of the above assumptions, gives the results in the following table.

Column i. is the cost of a lamp as given by the respective companies, with the above-mentioned exception. Columns ii. and iii. are taken directly from the report. Column iv., calculated with our formula, is dependent only on the efficiencies in column iii., and on the cost of a horse-power. Columns v. and x. are calculated from the results of the tests assuming that the survived lamp died as above explained. Columns vi. and xi. are calculated with our formula from columns v. and x., each combined with columns i. and ii. Columns vii. and xii. are the sums of column iv. with columns vi. and xi. respectively, and are the ultimate results which interest the consumer. Columns viii., ix., xiii. and xiv. are of interest to the manufacturer, showing how much of the total cost is due to the efficiency, that is, the power, and how much is due to the life and the cost of the lamp. Column xv. is the relative commercial rank of the different lamps as obtained from the results in column xii. It will be noticed that this is the same in the case of the Weston lamp whether the life, as given by the test, is taken, or whether the guaranteed life of 1,000 hours is taken.

As mentioned above, the Weston lamps used in the tests were unfortunately from a poor lot, and are not as good as their average lamps ; they were therefore pronounced useless by that company. The writer was informed by that company that they guaranteed their lamps to have a life of from 600 to 1,000 hours, depending on the nature of the installation, that is, whether the engine runs steadily, &c. The last two lines in the table were therefore calculated with this assumed life, and give the figures which can be justly compared with the rest. It will be noticed, however, that no

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matter whether the figures in column vii. or xii. are taken, or whether the life, as given by the test or as guaranteed, are taken, the Weston high tension lamp is still the most economical, with the assumed cost of a horse-power hour four cents. If the price is more than that, which it will be in many installations, the results will be still more in favour of the good efficiency lamps (see column iii.).

The way the results will be affected by a different cost of the power than that assumed, will easily be seen from the table. A higher cost of a mechanical horse-power hour than four cents. will decrease the relative ultimate costs for the high efficiency lamps, such as the Stanley 44 volt, the Woodhouse & Rawson and the Weston 110½ volt; while it will increase the relative ultimate costs for the poor efficiency lamps such as the others.

It will also be noticed from the table, columns viii., ix., xiii., xiv., that those lamps in which the cost for the power is a large proportion of the total cost, the life and cost of a lamp play but a small part in the whole cost, and that increasing the life will be of comparatively little value. But if in these lamps the efficiency be increased at the expense of the life, it will be a decided advantage. From the figures for the Edison lamps it will be seen that increasing the life from about 1,000 hours to 2,000 hours decreases the ultimate cost only about eight per cent.

Of the two assumptions made to determine the average life of the lamps, column v. gives undoubtedly too low results, while in column x. they are probably slightly too high, as many of the dead lamps have a discolouration of less than five on the scale, and it is probable that the survived lamps would not have lived until their discolouration was five. The real values of the ultimate cost will, therefore, no doubt be lower than the figures in column vii. and higher than those in column xii. But by comparing these last two columns it will be seen that the relative values for the different lamps are not changed very much, in fact, leaving out the low voltage lamps (Weston 70 volt and Stanley 44 volt), which the writer believes are seldom used, the relative rank remains the same whether the results in column vii. or xii. are taken. Therefore, although the necessary assumptions made to determine the life of the survived lamps, are from their nature not absolutely correct, they show that for two extreme cases the relative values are not changed, and therefore the real relative values which lie between the extremes will be the same.

The writer wishes furthermore to call attention to the fact, that in the above calculations and comparisons there is no "personal" factor, the results being obtained from figures only, and can be calculated by any one from the results of the tests of the Franklin Institute.

Name of lamp.	Cost, in cents, of a single lamp.	Mean spherical candle-power at beginning of test.	Efficiency in watts per spherical candle-power.	Cost, in cents, of power for 1 spherical candle-power hour.	Assuming survived lamps to have died at end of test. Average life in hours.	Cost, in cents, of lamp for 1 spher. C.P. hour.	Total cost, in cents, for 1 spher. C.P. hour.	Per cent. of cost for power.	Per cent. of cost for lamp.	Assuming survived lamps to have died when their discolouration would have been 5. Average life in hours.	Cost, in cents, of lamp for 1 spher. C.P. hour.	Total cost, in cents, for 1 spher. C.P. hour.	Per cent. of cost for power.	Per cent. of cost for lamp.	Relative commercial rank of lamps from column xii.
No. of Columns.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
Edison	85	15·47	4·459	·0287	1026	·0054	·0341	84	16	2038	·0026	·0313	92	8	2
Stanley 96 volt	70	13·59	4·04	·0260	430	·0120	·0380	68	32	501	·0103	·0363	72	28	4
Stanley 44 volt	70	13·42	3·544	·0228	293	·0177	·0405	56	44	319	·0163	·0391	58	42	5
Woodhouse & Rawson, 1st lot	120	15·64	3·605	·0232	290	·0264	·0496	47	53	...	...	...	...	...	...
Woodhouse & Rawson, 2nd lot	120	18·30	3·56	·0229	267	·0246	·0475	48	52	305	·0215	·0444	52	48	6
White	100	12·44	4·05	·0261	273	·0294	·0555	47	53	407	·0197	·0458	57	43	7
Weston 110½ volt	85	16·43	3·713	·0238	507	·0102	·0340	70	30	1022	·0051	·0289	82	18	1
Weston 70 volt	85	15·18	4·51	·0290	461	·0121	·0411	71	29	1012	·0055	·0345	84	16	3
Weston 110½ volt	85	16·43	3·713	·0238	600*	·0086	·0324	73	27	1000*	·0052	·0290	82	18	(1)
Weston 70 volt	85	15·18	4·51	·0290	600*	·0093	·0383	76	24	1000*	·0056	·0346	84	16	(3)

* Guaranteed life.

A PALACE OF DELIGHT.

Some few weeks ago a paragraph appeared in these columns announcing that a memorial was to be erected to the late Sir Titus Salt, Bart., which was to take the form of new science and art schools, to be added to the Salt Schools at Saltaire. It was further intimated that the opening of the schools was to be inaugurated by "A Palace of Delight." What this Palace of Delight was to be was then only slightly foreshadowed. The project has since undergone rapid and extensive development. Its limits have now been defined while at the same time the securing of the exhibits and the general arrangements of the exhibition are in a forward state. It has been decided that new schools will be erected on a site adjoining the existing institute, the cost of the new department being estimated at between £8,000 and £10,000. The main feature of the "Palace of Delight" is the fact that it will assume the form of a gigantic garden, eight acres of ground having been appropriated for the purpose. The garden will be surrounded on all four sides by a covered shed similar to that used at the Inventions Exhibition, and on the front side the new schools will stand. In these annexes 62,000 square feet of space is afforded, while the present institute and the new schools contain together about 41,500 square feet of floor, so that altogether 103,500 square feet of floor space will be available for the purposes of the exhibition.

The garden will have an average width of about 450 feet, and a length of over 600 feet. In the centre of the whole will be an illuminated fountain, similar to that seen at the Inventions Exhibition, the basin of which will be 90 feet square. On the south side of the garden facing this fountian will be a covered grand stand, from which a fine view of the playing water will be obtained. The lack of such accommodation was noticed by many visitors to the Inventories. Among the other many special features of the exhibition is an enormous circular tent, which is to be put up at the north-east corner of the garden. This will be one of the largest tents ever erected in England. In other parts of the garden the electric railway and a telpher line will be shown at work. Messrs. Woodhouse & Rawson have undertaken the lighting by electricity of the grounds, the sheds, and the picture galleries; and we observe that Messrs. Marshall, Sons & Co., Limited, of Gainsborough, have offered to build and lend three specially-constructed engines of 100 horse-power each, fitted with Hartnell's patent expansion gear, to work the dynamos. The Postmaster-General will consign for exhibition a complete set of telegraphic apparatus from the earliest time. It is expected that the exhibition will have a postal and telegraph office for its own work. Rapid progress is being made in the new building; operations proceed before sunrise and after sunset by the electric light.

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EXPERIMENTS WITH TRAMWAY MOTORS.

In our leading columns we have, as briefly as the subject will allow, touched upon the paper read by Captain Douglas Galton, F.R.S., on Wednesday evening, before the Society of Arts, and entitled: "Results of Experiments on Mechanical Motors for Tramways made by the Jury on Railway Appliances at the Antwerp Exhibition." The complete paper can be studied in the journal of the Society, our purpose being served by reproducing that portion directly connected with our province. We therefore commence with a detailed description of the electrically propelled car to which Captain Galton thus alludes :—

In the electric tramcar the haulage was effected by means of accumulators. The car was of the ordinary type with two platforms. It was said to have been running as an ordinary tramcar since 1876. It had been altered in 1884 by raising the body about six inches, so as to lift it clear of the wheels, in order to allow the space under the seats to be available for receiving the accumulators, which consisted of Faure batteries of a modified construction. The accumulators employed were of an improved kind, devised by M. Julien, the under manager of the Electric Company, which undertook the work.

The principal modification consists in the substitution, for the lead core of the plates, of one composed of a new unalterable metal. By this change the resistance is considerably diminished, the electromotive force rises to 2·40 volts, the return is greater, the output more constant, and the weight is considerably reduced. The plates being no longer subject to deformation, have the prospect of lasting indefinitely. The accumulators used were constructed in August, 1884.

The car, as altered, had been running as an electric tramcar on the Brussels tramways since October, 1884, till it was transferred to the experimental tramway at Antwerp. The accumulators had been in use upon the car during the whole of this period, and they were in good order at the end of the experiments, that is to say, when the exhibition closed at the end of October, 1885.

There were 36 of these accumulators enclosed in ebonite boxes, each weighing 44 lbs., the total weight being 1,760 lbs. (? 1,584 lbs. —Eds. Elec. Rev.). They were charged in a shed with a Gramme machine of the ordinary kind, giving a current of 20 ampères and 90 volts, driven by a portable engine.

The process of charging occupied 12 hours with a current of 13 ampères (? 23.—Eds. Elec. Rev.); and when complete, the batteries were able to work for 15 hours, and drive the car 46 miles, not counting the stoppages.

The accumulators actuated a Siemens dynamo such as is used for lighting, having a normal speed of 1,000 revolutions, fixed on the frame of the carriage. The motion was conveyed from the pulley on the dynamo by means of a belt passing round a shaft fixed on movable bearings to regulate its tension, and thence to the axles by means of a flat chain of phosphor bronze. The chain was adopted as the means of moving the axle, on account of its simplicity, and facility of repair by unskilled labour.

The speed was fixed at 4 metres per second (which corresponds with a speed of nearly 9 miles per hour), for 1,000 revolutions of the dynamo; and it was regulated by cutting a certain number of the accumulators out of circuit, instead of by the device of inserting resistances which cause a waste of energy. By breaking the circuit entirely the motive power ceased, and the vehicle might either be stopped by the brakes or allowed to run forward by gravity, if the road were sufficiently inclined. The reversal of the motor was effected by means of a lever which reversed the position of the brushes of the dynamo.

The dynamo could be set in motion, and the carriage worked from either end, as desired. The handle to effect this was movable, and as there was only one handle, and this one was in charge of the conductor, he used it at either end as required.

The weight of the tramcar was 5,654 lbs.; the weight of the accumulators was 2,460 lbs. (? see above.—Eds. Elec. Rev.); the weight of the machinery, including dynamo, 1,232 lbs. The car contained room for 14 persons inside and 20 outside. Under the conditions of the competition the car was required to draw a second car occasionally.

The jury made special observations upon the work required to move the car between the 20th September and 15th October, 1885. Seals were attached to the accumulators. Moreover, from the 27th of September, after each charge, seals were placed on the belts from the steam engine to prevent any movement of the Gramme machine, so that there could be no charges put into the accumulators beyond those measured by the jury.

The instruments used for measuring were Ayrton's ampèremeter and Deprez's voltmeter, which had been tested in the Exhibition by the Commission for Experiments on Electrical Instruments, under the presidency of Prof. Rousseau. Besides these, Siemens electro-dynamometer and Ayrton's voltmeter were used to check the results; but there was no practical difference discovered. During the period of charging the accumulators, the intensity of the current and the electromotive force was measured every quarter of an hour, and thence the energy stored up in the battery was deduced. It may be mentioned that the charge in the accumulators, when the experiments were commenced, was equal in amount to that at their termination.

An experiment was made on 21st October to ascertain, as a practical question, what was the work absorbed by the Gramme machine in charging the accumulators. The work transmitted from the steam engine was measured every quarter of an hour by a Siemens dynamometer, at the same time the intensity of the electromotive force given out by the machine, as well as the number of the revolutions it was making, was noted. It resulted that for a mean development of 4 mechanical horse-power, the dynamometer (? dynamo.—Eds. Elec. Rev.) gave into the accumulators to be stored up 2·28 electrical horse-power, or 57 per cent. The intensity varied between 25·03 and 23·51 ampères during the whole time of charging. Of this amount stored up in the accumulators a further loss took place in working the motor; so that from 35 to 40 per cent. of the work originally given out by the steam engine must be taken as the utmost useful effect on the rail.

It was estimated that to draw the carriage on the level ·714 horse-power was required, or if a second carriage was attached, ·848 horse-power would draw the two together. This would mean that, say 2 horse-power on the fixed engine would be employed to create the electricity, for producing the energy required to draw the carriage on the level.

The electric tram-car was quite equal in speed to those driven by steam or compressed air, and was characterised by its noiselessness and by the ease with which it was manipulated.

Assuming the car, by itself, cost the same as an ordinary tram-car, the extra cost relatively to other systems was stated as being, according to the following figures, viz. :—The Gramme machine cost £48, the motor £208, and the accumulators 2·25 francs per kilogramme (10d. per pound). To these must be added the cost of erection, and of switches for manipulating the current ; as well as the proportion of the cost of a fixed engine to create the electricity.

The original programme of the conditions which were laid down in the invitation to competitors, as those upon which the adjudication of merit would be awarded, contained twenty heads, to each of which a certain value was to be attached; and in addition to these special heads, there were also to be weighed the following general considerations, viz. :—

a. The defects or inconveniences established in the course of the trials.

b. The necessity or otherwise of turning the motor, or the carriage with motor, at the termini.

c. Whether one or two men would be required for the management of the engine.

As regards these preliminary special points, the compressed air motor, as well as the Rowan engine, required to be turned for the return journey, whereas the other motors could run in either direction.

In regard to this, the electric car was peculiarly manageable, as it moved in either direction, and the handle by which it was managed was always in front, close to the brake. This carriage was the only one which was entirely free from the necessity of attending to the fire during the progress of the journey, for even the compressed air engine had its small furnace and boiler for heating the air.

All the motors under trial were managed by one man.

The several conditions of the programme may be conveniently classified in three groups under the letters, A, B, C.

The conditions under A are :—

1. Absence of steam.
2. Absence of smoke and cinders.
3. Absence, more or less complete, of noise.
4. Elegance of aspect.
5. The facility with which the motor can be separated from the carriage itself.
6. Capacity of the brake for acting upon the greatest possible number of wheels of the vehicle or vehicles.
7. The degree to which the outside covering of the motor conceals the machinery from the public, whilst allowing it to be visible and accessible in all parts to the engineer.
8. Facility of communication between the engineer and the conductor of the train.

In deciding upon the relative merits of the several motors, so far as the eight points included under this heading are concerned, it is clear that, except, possibly, as regards absence of noise, the electrical car surpassed all the others.

The compressed air car followed, in its superiority in respect of the first three points, viz., absence of steam, absence of smoke, and absence of noise ; but the Rowan was considered superior in respect of the other points included in this class.

Under letter B have been classed considerations of maintenance and construction.

9. Protection, more or less complete, of the machinery against the action of dust and mud.
10. Regularity and smoothness of motion.
11. Capacity for passing over curves of small radius.
12. The simplest and most rational construction.
13. Facility for inspecting and cleaning the interior of the boilers.
14. Dead weight of the train compared with the number of places.
15. Effective power of traction when the carriages are completely full.
16. Rapidity with which the motor can be taken out of the shed and made ready for running.
17. The longest daily service without stops other than those compatible with the requirements of the service.
18. Cost of maintenance per kilometre. (It was assumed, for the purpose of this sub-heading, that the motor or carriage which gave the best results under the conditions relating to paragraphs 9, 10, 12, and 13, would be least costly for repairs.)

As regards the first of these, viz., protection of the machinery

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against dirt, the machinery of the electrical car had no protection. It was not found in the experiments at Antwerp that inconvenience resulted from this; but it is a question whether in very dusty localities, and especially in a locality where there is metallic dust, the absence of protection might not entail serious difficulties, and even cause the destruction of parts of the machinery.

In respect of the smoothness of motion and facility of passing curves, the cars did not present very material differences, except that the cars in which the motor formed part of the car had the preference.

In the case of simplicity of construction, it is evident that the simplest and most rational construction is that of a car which depends on itself for its movement, which can move in either direction with equal facility, which can be applied to any existing tramway without expense for altering the road, and the use of which will not throw out of employment vehicles already used on the lines; the electric car fulfilled this condition best, as also the condition numbered 13, as it possessed no boiler.

In respect to No. 14, viz., the ratio of the dead weight of the train to passengers, if we assume 154 lbs. as the average weight per passenger, the following is the result in respect of the three cars in which the power formed part of the car :—

$$\text{Electric car} \quad \ldots \quad \ldots \quad \frac{9{,}350 \text{ lbs.}}{154 \times 34} = 1{\cdot}78.$$

$$\text{Rowan} \quad \ldots \quad \ldots \quad \ldots \quad \frac{15{,}950 \text{ lbs.}}{154 \times 45} = 2{\cdot}30.$$

$$\text{Compressed air} \quad \ldots \quad \frac{22{,}000 \text{ lbs.}}{154 \times 56} = 2{\cdot}55.$$

The detached engines gave, of course, less favourable results under this head.

Under head No. 15 the tractive power of all the motors was sufficient during the trials, but the line was practically level, therefore this question could only be resolved theoretically, so far as these trials were concerned, and the table before given affords all the necessary data for the theoretical calculation.

As regards the rapidity with which the motors could be brought into use from standing empty in the shed, the electric car could receive its accumulators more rapidly than could the boiler for heating the exhaust of the compressed air car be brought into use.

As regards the steam motors, the following were the results from the time of lighting the fires :—

The Rowan—

In 34 minutes ... ... 3 atmospheres.
36 " ... ... 4 "
(At this pressure the vehicle could move.)
40 minutes ... ... 8 "

The Wilkinson—

In 35 minutes ... ... 2 atmospheres.
40 " ... ... 4 "
44 " ... ... 6 "
47 " ... ... 8 "

The Krauss machine required two hours to give 6 atmospheres, which was the lowest pressure at which it could be worked.

The results under No. 17, viz., the fewest interruptions to the daily service, class the motors in the following order :—Krauss, Electric, Rowan, Wilkinson, Compressed air. The chief cause of injury to the compressed air motor arose from the carelessness of the drivers, who allowed the steam boiler to be burnt out. Unfortunately these drivers were new to the work.

Under letter C are classed considerations of economy in the consumption of materials used for generating the power necessary for working.

TABLE.

Description of motor.	Total number of train miles run.	Total consumption of fuel.	No. of lbs. per train mile.
		lbs.	
Electric ...	2,358·9	14,786·	6·16
Rowan ...	2,616·9	14,498·	5·42
Wilkinson ...	2,473·3	22,000·	8·82
Krauss ...	2,457·8	22,726·	9·10
Compressed air	2,259·1	90,420·	39·48

TABLE.

Description of motor.	No. of places indicated on the cars, per mile run.	Consumption of fuel.	No. of lbs. of fuel consumed per places indicated per mile run.
		lbs.	
Electric ...	80,203·5	14,786·	·18
Rowan ...	148,399·6	14,498·	·09
Wilkinson ...	119,085·1	22,000·	·18
Krauss ...	108,983·9	22,726·	·20
Compressed air	128,189·3	90,420·	·69

TABLE

Description of motor.	No. of seats per mile run.	Consumption of fuel.	No. of lbs. of fuel consumed per seat per mile run.
		lbs.	
Electric ...	61,591·2	14,786·	·23
Rowan ...	135,928·8	14,498·	·10
Wilkinson ...	93,965·6	22,000·	·23
Krauss ...	86,039·9	22,726·	·25
Compressed air	132,732·7	90,420·	·66

19. Minimum consumption of fuel (either coke or coal), in proportion to the number of kilometres run, and to the number os places, assuming for the seats a width of at least sixteen inches for each person seated.

It must be borne in mind that the conditions of the competition required that a second car should be periodically drawn by the motor, and that the calculations which follow include the total number of miles run, the total amount of fuel, &c., consumed; and the total number of passengers which could be conveyed by each motor, during the total time that the experiments were being carried on.

As regards the figures in these tables, it is to be observed that the consumption of fuel for the electric car is, to a certain extent, an estimate; because the engine which furnished the electricity to the motor also supplied electricity for electric lights, as well as for an experimental electric motor which was running on the lines of tramway, but was not brought into competition.

20. Minimum consumption of oil, or grease, tallow, &c. (the same conditions as in No. 19).

TABLE

Description of motor.	Total number of miles run.	Total consumption of oil, tallow, &c.	Consumption of oil, tallow, &c., per train mile run.
		lbs.	
Electric ...	2,358·9	99·0	·038
Rowan ...	2,616·9	106·7	·038
Krauss ...	2,457·8	188·5	·073
Wilkinson ...	2,473·3	255·4	·101
Compressed air	2,259·1	585·2	·255

CONCLUSION.

The general conclusion to which these experiments bring us is, that, undoubtedly, if it could certainly be relied upon, the electric car would be the preferable form of tramway motor in towns, because it is simply a self-contained ordinary tramcar, and in a town the service requires a number of separate cars, occupying as small a space each as is compatible with accomodating the passengers, and which follow each other at rapid intervals.

But the practicability and the economy of a system of electric tramcars has yet to be proved; for the experiments at Antwerp, whilst they show the perfection of the electric car as a means of conveyance, have not yet finally determined all the questions which arise in the consideration of the subject. For instance, with regard to economy, the engine employed to generate the electricity was not in thoroughly good order, and from its being used to do other work than charging the accumulators of the tramcar, the consumption of fuel had to be, to some extent, estimated. In the next place, the durability of the accumulators is still to be ascertained; upon this much of the economy would depend. And in addition to this question, there is also that of the durability of parts of the machinery if exposed to dust and mud.

In England, with our depressed trade and agriculture, there is a great want in many parts of the country of a cheap means of conveyance from the railway stations into the surrounding districts; such a means of conveyance might be afforded by light railways along or near the road side, the cost of which would be comparatively small, provided that the expensive methods of construction, of signalling, and of working, which have been required for main lines, and which are perfectly unnecessary for such light railways, were dispensed with.

It is certain that this question will acquire prominence as soon as a system of local government has been adopted, in which the wants of the several communities have full opportunity of asserting themselves, and in which each local authority shall have power to decide on those measures which are essential to the development of the resources of its own district, without interference from a centralised bureaucracy.

Incandescent Lamp Tests.—Mr. Carl Hering's paper dealing with the results obtained by the Franklin Institute is of a decidedly practical character and will well repay perusal.

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THE REIS TELEPHONE.

PROFESSOR EDWIN J. HOUSTON, who is publishing in the *Journal of the Franklin Institute* a series of interesting papers entitled "Glimpses of the Electrical Exhibition,"* writes as follows respecting the Reis telephone:—

In concluding the brief history we have given of Reis's invention of the articulating telephone, we have thought it advisable, as far as possible, to append the views of some of the leading scientific men in the United States concerning the position which, in their opinion, Reis occupied as regards the invention of the articulating telephone. The list is by no means exhaustive; nor has any attempt been made to obtain the opinions of those known to be adverse to Reis. It fairly shows the error of the statement that the leading scientific men of America recognise and fully endorse the pretensions of Bell.

The following circular letter was sent, viz.:—

Hall of the Franklin Institute, Philadelphia, 1885.

My Dear Professor,—I purpose concluding my articles on the Reis telephone, with a publication of the opinions, as far as I can obtain them, of some of the scientific men in the United States, as to the part taken by Reis in the invention of the articulating telephone.

Will you therefore write me at your earliest convenience, your opinion as regards the following interrogatories, viz.:—

First. Please say whether or not in your opinion Reis was the inventor of the speaking telephone?

Second. Whether, if it was a speaking telephone, it worked substantially in the same way as the Bell telephone, or not?

Third. Whether the electrical current employed in the transmission of speech was an undulatory current in the same sense as it is in the Bell telephone, or not?

Fourth. Whether Reis ever actually succeeded in transmitting articulate speech as he claimed?

Fifth. Whether the defects in the Reis apparatus are to be attributed to his transmitters, or to a want of sensitiveness in his receivers?

Sixth. Whether the modern transmitting telephones of the variable contact type are anything more than the Reis transmitters with carbon substituted for the platinum contacts?

Thanking you in advance for your courtesy in the matter,

I am, very respectfully,

EDWIN J. HOUSTON.

Prof. A. E. Dolbear in answer to the above kindly sent me in addition to a very full reply by himself, a number of letters received by him from scientific men, referring to the same subject, with permission to publish the same.

Tuft's College, College Hill, Mass., *October*, 1885.

Prof. Edwin J. Houston—

My Dear Prof.,—I have taken great pains to learn what Reis did with his telephone and what is possible with it, and I think it possible that I have made many more experiments with it than Reis himself did. The whole interest in the present controversy centres in Reis's transmitter, as to whether it is, and was in Reis's hands, capable of so modifying an electric current, through the automatic action of sound vibrations, as to produce what is now called the undulatory current, and of transmitting articulate speech. Now the structure of Reis's transmitters is so well known that a detailed description is not needed. All of them (for he made eight or ten forms) were so made that sound vibrations of any sort should act upon a diaphragm, carrying an electrode, upon which rests with gentle pressure, either by a spring or by its own weight, another electrode, these being part of an electric circuit, the intent evidently being that the actual movements of these electrodes, when actuated by sound vibrations, should modify the strength of the current so that it should represent as nearly as possible the wave movements in the air. If Reis's apparatus was not *intended* to duplicate such air movements by changing the energy of the current by the transmitter, I can see no use for Reis's figures of compound sound waves and his extended explanations of them. Whether apparatus so made and used will so modify a current is simply a matter of fact and in no wise depends upon anyone's theory of electricity, or sound, or molecular action, or of make and break of circuit. It ought not to be lost sight of, nor kept obscure, although every effort has been made to divert attention from it, that Reis's transmitter like every other kind of transmitter acts *automatically* when it works at all, and its individual vibrations cannot be controlled by anyone. Whether there will be a make and break of contacts or not, depends upon the rate of vibration and the amplitude of vibration of the diaphragm. If the amplitude be great and the rate low, the electrodes will not separate, for the free one can follow the movements of the membrane. If the amplitude be small and the rate high they cannot separate; in either case there will be only a variation of pressure of the electrodes at the point of contact. So much is purely mechanical and automatic, but it needs to be said and emphasised, for, first, it is true; and second, because this was lost sight of by the Courts, and has cunningly been evaded by those interested in the denial of Reis's claims to be considered as the inventor and maker of the first speaking telephone. Everyone who has experimented with Reis's transmitter knows that it will transmit articulate speech, except a few, a very few, who have an interest in not knowing. I have known one such to find a convenient excuse for absence when he had good reason for thinking that by staying, his expressions of opinion would have to undergo revision.

Now Reis invented a device which he called *The Telephone*. He described its structure so that others could make similar ones, and in addition he undertook to explain throughout its mode of operation, a work which it is impossible to complete even to-day with all the advance in the knowledge of electricity and mechanics. It is in his explanation of the mode of operation of the instrument that he speaks of making and breaking the current. It might fairly be asked how Reis could absolutely know that there was a make and break for every vibration supposing that it did actually occur. He could not prove it, and, as a matter of fact, it is mechanically impossible that it should make and break the circuit for every vibration for complex sounds.

Let us suppose that we are in Reis's room, where his apparatus is set up, and we ask him how it is to be used? He says to one at the transmitter "Make sounds of *any kind*, it will transmit them," and to the one at the receiver "simply listen at the receiver." The first sings and speaks, and the latter says he heard the singing and words. Ask Reis to explain how the thing is done and he talks about makes and breaks of the current at the movable contacts of the transmitter. But Reis, how do you know that it makes and breaks for every vibration when it is transmitting words? Reis didn't and couldn't know. What Reis was doing, was helping his auditors to an easy conception of the possibilities of his apparatus, and I submit that at this day his explanation is the shortest and simplest for any who are not somewhat skilled in physics. I am not saying that it is not possible to transmit speech by a make and break circuit for every vibration, because McDonough with his wheel has demonstrated that it can be done, and has thus proved that Reis was right, if such a construction be put upon his words. What I am saying, is, that if Reis *intended* that his apparatus should make and break the circuit for every vibration, then he failed, for his apparatus won't do it. It works *automatically* when it works at all and does not depend upon the *intention* of the speaker to make and break for every vibration. In the Spencer case, Judge Lowell gave the famous decree that 100 years of Reis would not make a speaking telephone. The 100 years is up, however, and McDonough with his *make and brake* wheel says *hello*, easily recognised by Profs. Young and Brackett, and many others, as well as by myself.

When Sir Wyville Thomson sent home from the *Challenger* his observations on *bathybius*, Prof. Huxley sought the first print to say that he was mistaken when he gave the substance its name and philosophical importance—an example which a $20,000,000 monopoly could not afford to have followed.

Again, it is admitted everywhere that there is no *mechanical distinction* between the Reis transmitter and the Blake transmitter, and that the efficiency of the latter depends upon the employment of carbon where Reis used platinum. Does any one think that Reis would have explained his device differently if he had used the substitute? or, that he would not have had a speaking telephone comparing well with any we have to-day?

It has been affirmed again and again that if Reis's transmitter will transmit now, it is because we apply knowledge to it which has been acquired since 1876. Take then a Reis transmitter that has not been touched since 1864, if such an one can be found, and connect it properly in circuit with a battery and connecting wire. If it be spoken to will it act microphonically or not? Any one having knowledge enough of the apparatus to be entitled to an opinion, who should say that it would not, would be entitled to admiration for his hardihood. If it will work microphonically it is because such action is *inherent in the mechanism* and not on account of any knowledge imported into it, and any such assumption is a fiction, warranted by nothing except the necessity for denying the right of the public to use that instrument for the purpose for which it was made. One may sing to it, may whistle or screech at it, but remember that if anyone hears a word from it the Bell Company is entitled to his head. "The law allows it and the court awards it."

But making no distinction between the description of a piece of apparatus and the explanation of its mode of operation, giving the merit of the invention to the man who properly explains it would make fine work throughout science. Let us see! When Crookes made and exhibited those wonderful tubes called *radiometers*, he explained their action as being due to the direct action of light upon the delicately-poised vanes. He *intended* that the impact of light waves should propel the vanes, and they certainly rotate as he also *intended*. Afterwards Stoney and others, better acquainted with thermo-dynamics than was Crookes, gave a more consistent interpretation of the motion, but I have yet to hear that 100 years of Crookes wouldn't make a radiometer. Is it because there was no $20,000,000 behind it? Brewster invented the kaleidoscope, but as long as he lived he explained its phenomena on the basis of the corpuscular theory of light. Brewster's claim was not denied. Was it because there was no $20,000,000 behind it?

If Daguerre explained the action of light upon his sensitive silver plate as being due to the formation of a solar salt upon it,

* Philadelphia, 1884.

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the degrees of shade depending upon the amount formed, he was altogether wrong, but the one who explained the chemical action upon the plate, made no claim to the discovery of photography. Was it because there was no $20,000,000 behind it? Let one invent a new galvanic battery cell and describe it, telling what solids and liquids to use and their proper disposition in the cell. Let him explain that it is his *intention* that the ammonia shall combine with the zinc, and the chlorine be set free upon the carbon. The battery shows when it is set up, that that evidently was the intention, for the elements are placed in proximity and are free to *if they will*. The courts may declare that what he invented was what he explained, not what he made—if there be $20,000,000 that want the invention.

Grove invents a galvanic battery and describes its make up, and explains its action on the *chemical* theory of electricity; Bunsen improved it by substituting carbon for the platinum and explains the whole on the *contact* theory of electricity, which is endorsed by Sir Wm. Thomson and many other physicists. What Grove had in mind was to produce electricity chemically. Bunsen had in mind the correct conditions for generating it, and his battery exemplifies it. A hundred years of Grove will never make a galvanic battery, if there be $20,000,000 that want his invention.

Another point which has been made much of on one side, namely, that if Reis had succeeded in transmitting speech, that it is incredible that no more should have been heard of it, and that it is extremely unlikely that such a success should have remained uncredited for so many years as to be almost lost sight of. But the answer is at hand. It is not denied that Yeates, of Dublin, did transmit speech telephonically, in 1866, with his improved Reis apparatus. Did it attract any attention? Was it even chronicled? Why was no public mention made of it? Simply because it was considered a curious toy and not of commercial importance.

To sum up, then, in my opinion:—

1st. Reis invented a speaking telephone capable of transmitting words, that he intended it for that purpose and used it with success, for he says in his so-called *prospectus* when giving directions for using it "sing," "speak." He also says directly in one of his lectures, "*words were transmitted*." This is also the testimony of a considerable number of those who were with him, Quinke, Messel, and others. One of the most eminent scientific men in the United States said to me: "The testimony of Quinke alone is enough to settle that point."

2nd. That Reis's transmitter works in precisely the same way, while transmitting speech, as do the modern ones, namely by what is called *microphonic action*.

3rd. That the only difference of any importance between the Reis transmitter and the modern commercial one, is in the material, carbon being substituted for platinum for an electrode, which renders it more efficient but does not change the method of operation.

4th. That the main reason why Reis obtained no better results than he did, was due much more to the lack of sensitiveness in his receiver than to defects in his transmitter. The weaker vibrations, though present, being so much diffused as to be often inaudible. The modern receiver is more efficient on account of its boxing. There is no principle or mode of operation in the modern telephone which was not known and embodied in instruments made for the purpose twelve years before the famous patent of 1876. This patent could not have been for a *new art*. The Bell Company knows all this as well as anyone, and is in constant fear that the courts will find it out. Ask a Bell man: "What is a Reis transmitter?" and he will answer: "One that will not transmit speech." "What is a Bell transmitter?" Ans.: "One that will transmit speech." "If a Reis transmitter transmits speech, whose transmitter is it?" Ans.: "Bell's."

To show that I am not alone in my opinion upon these points I append the opinions of other scientific men in the country to whom I applied, asking them to state what their views were upon Reis's telephone, and give me permission to quote them. As will be seen, there are not two opinions about it any more than there are two opinions as to whether the earth is flat, though there may be here and there a man like "Parallax" in England who is stoutly defiant. Yours truly,

A. E. DOLBEAR.

Physical Laboratory of Washington University,
St. Louis, *May* 21*st*, 1885.

Prof. A. E. Dolbear—

Dear Sir,—Replying to your question concerning the difference between the action of the Reis transmitter and the ones now in use by the Bell Company, I reply that I cannot see that there is any difference in the method or manner of working. It is a source of amazement to me that the courts have decided differently, and I regard it as a very great disgrace, arising I hope from ignorance.

I do not think that either Reis or Bell were perfectly successful in describing the working of the transmitter, but of the two Reis is ahead.

Reis describes clearly the character of sound waves, and wishes to have these sound waves act upon his transmitter so as to produce changes of a similar character in the electrical apparatus, in order that these sound waves may be again reproduced by his receiver. He seems to have fixed his attention upon the magnetic field, or magnetic condition of his receiver, and knowing that a break in the circuit did not abruptly extinguish the current, by reason of the self induction of the wire coils, and that the closing of the circuit was followed by a gradual rise to the maximum current, he thought a make and break between spring contacts would accomplish what he clearly saw was necessary. He knew also that similar retardation occurred in the magnetisation and demagnetisation of the iron core. He seems to have understood all this much more clearly than Bell, who draws lines like this to represent the case of a make and break circuit.

Reis seems to have intended to produce wave-like changes in the magnetic condition of his receiver, and this is precisely what is necessary, *and it is precisely all that is necessary, in order to transmit articulate speech.*

When a circuit containing an electro-magnet is opened and closed, the changes in the magnetic condition of the magnet are necessarily wave-like, and Reis may have thought, therefore, that a make and break would serve to accomplish the result at which he aimed. But we know now that under the conditions which are supplied in the Reis transmitter, the wave forms are not of the proper shape to reproduce speech if the circuit is opened and closed at the working contact. The fact is that when the Reis instrument does transmit speech, the circuit does not open and close, and whatever Reis may have thought about it, it did not make and break the circuit when it worked successfully in his hands. It worked by varying the resistance at the loose contact, precisely as the "modern" instruments work to-day. The result at which Reis aimed was to produce the proper variations in the magnet strength. He succeeded in doing this in an imperfect manner. But that he did succeed in doing it I cannot doubt. His main weakness was in the receiving instrument, which was not sensitive enough.

What I have written here seems so clear and evident to me, that I cannot avoid thinking ill of a man who says it is not true. Unless other considerations prevent, I class him among those who say the earth is flat.

I am not in any way financially interested in any kind of telephone, but I think it is time for scientific men to speak out on this subject, and, so far as I happen to know, they are practically of one mind.

It is not very likely to influence the legal decisions, but it may at least relieve American scientific men of the disgrace of giving even tacit countenance to a monstrous imposition.

Very sincerely yours,
FRANCIS E. NIPHER.

3208, Race Street, Philadelphia, Pa., *July* 22*nd*, 1885.

Prof. A. E. Dolbear—

Dear Professor,—(1.) There *will* be a telephone report.

(2.) I had supposed, without pretending to be a specialist, that there was but one way a telephone *could* work, and that, therefore, Reis had the idea which was made available later. I have not made that accurate historical research without which I simply should hold my judgment in suspense. Yours truly.

(Signed) LEONARD WALDO.

Yale College Observatory.

STATEMENT.

Having received a Reis instrument, same as "Fourth Form" described in Reis's own paper "On Telephony" in the annual report of the Physical Society of Frankfort-on-the-Main for 1860-61 (see p. 20 of Thompson's "Reis Inventor of the Telephone"), I had no slight curiosity to know whether it would or not transmit speech.

I connected my lecture room with the physical workshop, using about 20 lbs. of 18 office wire, one Grenet cell, and two Bell receivers in circuit. One of the receivers was located at opposite end of line in shop, while the other and Reis transmitter with the battery were on my table.

After securing fine *singing* adjustment (by *singing* I mean one that would cause the Bell receiver at my ear to hum freely when talking with the Reis), I found that my assistant in the shop could carry on conversation quite readily—so much so that we were both astonished at the results. He called others into the shop, and in more cases than one we fooled the hearers so completely that they supposed that we were using the regular Bell outfit at my end of the line.

We still use the circuit for communication between lecture room and shop without difficulty.

Surely no one who had ever seen a Reis telephone could claim thereafter to have invented the system of transmission of speech by electric pulsations or undulations.

(Signed) JOHN B. DEMOTTE, *Prof. of Physics.*

De Pauw University, Greencastle, Ind., *July* 21*st*, 1885.

Sheffield Scientific School of Yale College,
New Haven, Conn., *June* 3*rd*, 1885.

Prof. A. E. Dolbear—

Dear Sir,—It is certainly my impression that Reis's telephone embodies all the essential features of the systems now used, and that if it had been generally known, the exclusive patents which have proved so valuable would not have been granted; but I am unable, under the pressure of annual examinations and much other work, to undertake to either write out a carefully formulated opinion, or to make experiments in a field which is now chiefly of a historical or technical interest,

Yours very truly,
(Signed) CHARLES S. HASTINGS.

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Ohio Wesleyan University, Delaware, O.,
June 30th, 1885.

Prof. A. E. Dolbear, Tuft's College, College Hill, Mass.—

Dear Sir,—I have been experimenting with a telephone made according to the description that Reis gives of one that he made. It is an exact pattern of the one described by Reis. I am irresistibly forced to these conclusions from all the knowledge I can gain on the subject, viz., that Reis did invent a speaking telephone, and that as he invented and constructed it, it is capable of transmitting articulate speech, and that it did so in Reis's hands, and that as a transmitter it substantially works in precisely the same manner as any modern transmitter does when transmitting articulate speech. Reis's invention, the telephone, was undoubtedly what he made, he probably did not fully understand its mode of transmitting speech, nevertheless he made a telephone that in my hands fully and completely transmitted entire sentences. Reis's description of the operation of his instrument is one thing and its work another in my opinion; his invention is the telephone, an articulate speech transmitter, and not a description of its operations. I am, very truly yours,

(Signed) W. O. SEMANS,
Prof. Chem. and Physics.

Columbia College, N.Y., *May 28th*, 1885.

A. E. Dolbear, Esq.—

Dear Sir,—In answer to yours of April 29th, I would say, that in my opinion the Reis transmitter, when made and adjusted as the maker intended, is capable of transmitting articulate speech, operating like the Blake transmitter, the action being microphonic, and differing only in efficiency from modern instruments of this class; in other words, Reis in my opinion invented a speaking telephone, operating with precisely the same kind of currents now so commonly employed, the defect of the apparatus being in the lack of sensitiveness of the receiver. Very truly,

(Signed) OGDEN N. ROOD,
Prof of Physics in Col. Col.

Department of Physics, Cornell University
Ithaca, N.Y., *June 1st*, 1885.

My Dear Professor Dolbear,—I am under obligations to you for showing me, while you were in Ithaca last week, a genuine Reis, by which, when used as a transmitter in connection with a Bell magneto telephone as a receiver, conversation could be carried on with nearly the same facility as by the Blake transmitter. The experiment showed conclusively that the Reis telephone, with only platinum contacts, not only can transmit speech, but does so so clearly and distinctly that if we had not something better it would be considered a thoroughly successful transmitter.

Had Reis succeeded with his receiver as well as with his transmitter the speaking telephone would have been in universal use 10 years earlier than it was. Yours very truly,

(Signed) WM. A. ANTHONY, *Prof. of Physics.*

Princeton, N. J., *May 28th*, 1885.

My Dear Prof. Dolbear,—As to the matter we talked about, the case stands about thus in my opinion. Reis set out to make an instrument that would convey sounds electrically; there is no evidence that there was in his mind any limitation whatever as to the kind of sounds to be conveyed, and there is on the other hand considerable and conclusive evidence that he had in mind articulate sounds as well as musical tones. He constructed apparatus which would communicate musical sounds very well, and articulate speech partially; that is, he occasionally got speech through it; but not hitting upon *carbon* as the material of his transmitter electrodes, his success as regards articulate speech was not complete or satisfactory.

Being no business man, and looking at the thing from a scientific rather than a business point of view, he took out no patents, and made no attempts that I ever heard of to introduce his invention as anything more than a piece of interesting scientific apparatus. He did *publish* his results somewhat widely, and his instruments were put on sale as scientific apparatus.

His instruments, just as they came from his hands, will talk now, if manipulated carefully enough, and if *improved* by merely inserting a bit of carbon at the loose contact of the transmitter, would to-day answer satisfactorily for telephonic business; though of course anyone would admit that the receivers and transmitters now in use are better than such an apparatus would be. But his *receivers* will any of them operate fairly well with our modern microphone transmitters, and his *transmitters*, fitted with carbon electrode are excellent, even judged by the latest standard.

The fact that he spoke of his transmitter as working by "opening and closing" the circuit, and did not enter into any discussion as to the question of the completeness of the "make and break" in the transmission of words, does not appear to me to justify at all any attempt to deprive him of the credit of his invention. Perhaps the question did not raise itself in his mind, and perhaps it did; but however that may be, he invented an apparatus that would talk—rather capriciously it is true, for want of carbon, but still, when exactly adjusted, it would talk until the adjustment was disturbed. Nor, I think, can there be any question that the action of his apparatus, when thus talking under successful adjustment, is precisely the same as it would be if one of the electrodes was tipped with carbon, and the same also as the action of any of the ordinary carbon transmitters now in use.

As to the precise nature of the action at the "loose contact" of a transmitter, I think no one is yet entitled to speak with confidence. That it *may* consist of actual "makes and breaks" of the current in the ordinary acceptation of the term is proved to my satisfaction by McDonough's revolving wheel experiments; that it *may* consist on the other hand in a rapid variation of the strength of the current without complete "makes and breaks" is of course possible, since in the magneto telephone this is unquestionably the way the current acts. But as I view the matter, *whatever* the action may be, no man has a right now to claim exclusive ownership of it for having discovered an explanation of it, even if his explanation should turn out to be more accurate and exact (which need not yet be admitted) than that of the man who first used that action for the transmission of words. If Mr. Bell's explanation proves correct, well and good, he deserves *scientific credit* for it, but not *patent right* in it, as against Reis.

I do not know that this letter will answer your purpose, but if you can make any use of it, it is quite at your service to do what you like with it. Very truly yours,

(Signed) C. A. YOUNG.

U. S. Department of Agriculture.—Division of Chemistry.
Washington, D. C., *May 21st*, 1885.

Prof. A. E. Dolbear, College Hill, Mass.—

Dear Sir,—I have had the pleasure of testing a model of the Reis telephone, and was surprised at the distinctness with which his transmitter allows the passage of articulate speech. In the trial which I made of the instrument, the distinctness of the transmitted conversation was as marked as that of the ordinary telephone.

It seems to me that the only difference between the Reis transmitter and those of the modern telephone is in efficiency and not in principle. The trouble which Reis encountered in his experiments I am now convinced was in his receiver and not in his transmitter. Had he been provided with a receiver as delicate as those now in use, the telephone would have been a commercial success 20 years ago.

The transmitter which was used in the trials made in my presence was an exact reproduction of the one described in Reis's original drawings; and the result of the experiment leaves no doubt in my mind that Reis was the inventor of a speaking telephone.

Messrs. Richardson and La Dow, who were with me during the experiment, were also much pleased with the excellent action of the instrument. Respectfully,

(Signed) H. W. WILEY.

Ann Arbor, Mich., *June 17th*, 1885.

Prof. A. E. Dolbear—

My Dear Sir,—I can confidently assure you that I have heard speech transmitted in a satisfactory way by means of a Reis's transmitter. The instrument was a careful copy of one of the forms figured in Thompson's book on Reis's telephone, and the results were nearly or quite as satisfactory as I usually obtain with more recent forms of patented instruments. Sincerely yours,

CHARLES K. WEAD,
Prof. Physics, Univ. of Mich.

North-Western University, Evanston, Ill.,

Prof. A. E. Dolbear— *Oct. 10th*, 1885.

Dear Sir,—Respecting the Reis telephone, the evidence appears to me to be entirely conclusive on three points:

First. The Reis telephone, or a faithful copy of it, transmits speech to-day, "with a distinctness sufficient for everyone" to understand plainly.

Second. It transmitted during the lifetime of Reis himself. Of this we have evidence from contemporary printed accounts of its performance, and from *ear-witnesses*, if the word may be allowed.

Third. Reis designed the "*telephone*" to transmit speech. His own account of "Telephony," published in 1862, is unmistakeable on this point.

Philip Reis conceived the idea of transmitting speech and music by galvanic electricity, and constructed an instrument that actually did this, even though the laws of the composition of vocal and other sounds were not at that time well understood; and he should certainly have the credit arising from so great an invention. Very truly yours,

(Signed) H. S. CARHART, *Prof. of Physics.*

Boston, *Oct. 10th*, 1885.

Professor A. E. Dolbear—

Dear Sir,—In reply to yours asking for information concerning my knowledge of Philipp Reis and his relation to the telephone, would say that I had, previous to 1881, become so much interested in the subject that, happening to be in Germany, I resolved to visit the field of his labours that I might not only satisfy my curiosity but also judge for myself from the testimony of living witnesses, and from apparatus which Reis has left of the character of the work accomplished by him. Near the centre of the small village of Friedrichdorf, and directly opposite the post-office, stands the modest house where Philipp Reis formerly lived and which is still occupied by his family. There remain many evidences of his former presence. In the casement of the sitting-room window, electrical binding posts with wires leading to a room in the rear may still be seen. Placed there by Reis himself and used by him in making probably the greater part of those

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important investigations in the endeavour to perfect his apparatus for the transmission of speech. This was his aim, and anything short of that he considered of little importance—so said Mrs. Reis. A short distance further up the main street stands the Garnier Institute, where Reis as a teacher displayed a wonderful ingenuity in devising apparatus for illustrating the usual experiments in Physics and also evinced, as shown by several pieces in the collection, an originality in invention and research of a very high order.

Prof. Leon Garnier, Principal of the Institute, said he had often witnessed Reis's telephone experiments and repeated many words and sentences which he himself had heard through the apparatus.

I was next introduced to Herr Henry Holt. He thus related his first successful experience with the telephone. "I had been listening a long time, and heard nothing intelligible, when suddenly I plainly heard the words, '*I am through; come up.*' I went up, and was considerably surprised to find that that was exactly what Reis had said, and he then explained to me that the speech had been transmitted by the electric current." Mr. Holt said Reis was at the time highly elated over it. After that, he listened with much greater faith, and hence with closer attention, and, on many occasions, heard words and sentences. Reis was evidently sorely tried by the incredulity of those who in the earlier experiments assisted him, and who, consequently, were very careless and inattentive listeners. Many a joke did poor Reis encounter from his co-labourers and associates, but he eventually silenced them all; and, although they could not realise its importance, they yet recognised the fact that Reis had then made a speaking telephone, and that it was to him as the inventor of the speaking telephone, that the monument in the cemetery at Friedrichdorf was erected by the Frankfort Society. Many have, as you know, for selfish reasons, endeavoured to belittle that testimonial by claiming that it was the invention of the *musical* telephone, which it was intended to commemorate. Owing to the difficulty of making such delicate tests before a popular audience, the transmission of musical tones was given prominence at his lecture. It was with much pleasure that I visited the very building and room at Frankfort in which that famous first lecture of Reis on the telephone was given, and strolled through the garden across which the wires on that memorable occasion were stretched.

The original manuscript in Reis's handwriting had previously been shown to me by Mrs. Reis; she still has it, I believe, in her possession.

At the shop and factory of Albert, philosophical instrument maker, I learned several interesting facts. The Reis transmitter known as the *collar box* pattern was shown to me by Mr. Albert and he said, as seems probable, that it was made previously to the *square box* and subsequent to the bored block pattern. It seems to me that this must have been the order of sequence. I feel sure that Reis did not employ Albert until after his lecture before the Frankfort Society, where the *bored block* transmitter was used; moreover, Albert says he made the collar box pattern himself, and this more nearly resembles the *square box pattern*; involves the same ideas; and seems like its crude beginning.

The *collar box* and the *square box* patterns were, however, not intended as superior instruments, *i.e.*, instruments from which Reis could himself obtain better results, but were so made because they were automatic in their action. At that time there was a call for his apparatus and Reis reasoned that an instrument which dispensed with such delicate adjustment as the *bored block* required would be better to put into the hands of the unskilled experimenter.

Mr. Albert said there was a great difference in the performance of the transmitters even when made as nearly alike as possible. I have myself verified this experience of Mr. Albert. For example I have had a dozen of each of the parts of the *bored block* transmitter made and placed in piles by themselves each piece like its neighbour, and interchangeable like the parts of a Waltham watch. When set up, taking a piece from each pile, for each instrument, the transmitters could not be told apart except by the number stamped upon them. Upon testing them a great difference was observed in their performance. With some, talking could be transmitted at once, while others needed much adjusting and patience before they would do well even if they ever would. This explains why the various early writers concerning these telephones differ as to their capabilities. Some by chance obtained good instruments, others not so good although all seemed alike.

It was my good fortune, while in Europe, to obtain a pair of instruments which were exact fac-similes of those now held by the German Government and claimed to have been the first set sent out by Reis.

The transmitter was of the square box pattern and the receiver (the knitting needle pattern) corresponded to Pisco's minute description.

With these instruments I have at various times performed many hundred experiments. I have heard both words and unexpected sentences as plainly as with the best modern instruments. When so transmitting speech, the transmitter does its work in precisely the same manner as does the Blake, Edison, or other ordinary varying-contact transmitter. The current produced has variations precisely similar to the variations caused by carbon transmitters. By substituting a small piece of electric light carbon for piece of platinum foil, which terminates one of the electrodes of the *bored blocks* transmitters, I have obtained an instrument as good and as practical as a Blake transmitter. Indeed, the latter is then but a close imitation of the *Reis bored block*. With a transmitter thus modified, the Reis knitting needle receiver is a good practical receiving telephone. Its tones are clear and articulation excellent.

As the result of my investigations and experiments, I am thoroughly convinced that the Reis apparatus can and in the hands of Reis did transmit articulate speech, and that Reis should and will go down in history as the first and original inventor of the Electric Speaking Telephone.

(Signed) H. C. BUCK,
Electrician, 70, *Washington St., Boston.*

(To be continued.)

DEEP-SEA LIGHTHOUSES AND TELEGRAPH STATIONS.

ABOUT three years ago Mr. C. Anderson, of Leeds, read a paper before the Society of Engineers on a system of deep-sea lighthouses, intended to render navigation safer and communication with vessels in distress easier. That gentleman proposed to construct lighthouses in the form of a large cylinder of riveted ironwork, about 36 ft. in diameter and 290 ft. in length, and consisting of three parts. The upper portion was to rise 140 ft. out of the water, and to be in shape and detail constructed like the towers of an ordinary lightship. The central part was to be rendered unsinkable by packing it with material lighter than water. The lower portion, extending to 150 ft. below the water line, was to act as a ballasting and steadying power.

Recently a rival scheme has been brought forward and practically tested with a working model, which bids fair to effect similar results by means of a combined floating telegraph station and lightship, which is the invention of the late Captain Moody. The model, which has been constructed at the Barrow Shipbuilding Company's yard, resembles a floating telegraph station in almost every particular, and has a hull of a peculiar shape, being constructed with four equal rays or projections proceeding from a central circular deck, protected by an iron bulwark. In fact, the actual vessel may be said to be something like a square cushion, 80 ft. by 80 ft., with the sides indented. Openings are made through the deck to the interior of the vessel for companion ways and skylights, as well as scupper-holes round the bulwarks to take off any water that may be shipped in a storm, although, as a matter of fact, it is claimed for the novel vessel that, even in the heaviest seas, no water is shipped, on account of its great buoyancy. There is also said to be no danger whatever of foundering, owing to the clearing valves and the divisions into numerous water-tight compartments, and other contrivances. The vessel is also constructed to deflect the waves as they strike, instead of allowing them to break upon the deck. The vessel is to be held fast by four strong cables running from the curvatures between the rays, and if the vessel is to be moored in mid-ocean, these cables will be attached to cylinders or buoys sunk to a certain depth, and from these, again, will be cables with anchors. If the vessel is placed in any position near land, four cables with as many anchors only are required. The telegraph cable is to run through a well in the centre of the vessel, and cannot, it is stated, by by any possibility become twisted with the cable chains. If the vessel is also to be used as a lightship, the light is placed in an ordinary lighthouse lantern, placed on the top of a substantial lattice-work tower, 60 feet above the water-line, and made of steel, with ladders running up the inside. Steel wire ropes from the hull to the top act as stays to the towers. The vessel is to contain ample accommodation for the crew, as well as store and other rooms.

It is claimed for the new vessel, with its immense strength, its great floating surface, its arched form and water-tight compartments, which latter would act as bulk-heads, its great buoyancy, its power of deflecting the waves, and its whole general construction, that it is the best possible form of vessel for a floating lightship and telegraph station. The present form of vessel can only be made to swing with the wind and tide if placed in a seaway, but Captain Moody's can be moored in a triangle or by four cables, and can be kept in position whatever may be the state of wind or tide.

The trials which were made with the model last week off the yard of the Barrow Company are stated to have given great satisfaction, the vessel behaving splendidly in a very rough sea, taking each wave with an easy motion and shipping no water. The model is to be submitted to the Trinity Board, and later on to be sent to the Shipping Exhibition at Liverpool.

REVIEWS.

Magnetism and Electricity. For the Use of Students or Schools and Science Classes. By H. C. TARN, M.C.P., F.S.Sc. W. & R. Chambers: London and Edinburgh.

The object of this book is to make clear to a beginner all that is necessary for him to know in order to

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"make sure" of a first class in the elementary examination of the Science and Art Department. The author does not claim that it "supplies a want," but he leaves the work to be judged by its own merits; the latter, we consider, are decided. The work is written in a colloquial style which has its advantages, although in several cases it verges upon the "penny-a-line" of a very commonplace description; thus in the chapter on Telegraphy, which consists of two pages, we have the following rhapsody: "Signals may now be flashed through space with a velocity equalled only by the speed of light; time and distance become annihilated; and the remotest corners of the globe, if bound together by the civilising belt of wire, exchange their communications as though they were the nearest neighbours. Genius and invention have subdued all the difficulties connected with electric transmission; and nearly the whole of the civilised world is now *girdled* with the *vehicle* (the italics are our own) of intercourse." !!!! At the end of this chapter we have the following extraordinary antithesis: "The needle telegraph only *transmits* signals it does not *record* them." The author's notions on the use of amalgamated zinc in batteries seem a little foggy; thus we are informed that "the action of the mercury on the zinc produces a uniformity in the hardness of its surface, *enables the hydrogen to carry off with it the metallic impurities* which tend so much to the development of local currents."

L'Electricité à l'Exposition Universelle d'Anvers. Par CHARLES MOURLON. 2nd Edition. Bruxelles: Imprimerie du Mouvement Industriel Belge, 6, Rue de Poinçon.

This book is decidedly a commendable publication, and much information will be found in it which has not been published elsewhere except in a fragmentary condition. The illustrations are numerous and for the most part well executed.

NOTES.

The Electric Light in Ironworks.—The electric light is now being extensively employed in the ironworks of South Staffordshire. The arc system, which is used in some of the chief steelworks of the kingdom, has been found unsuitable to the low roofs of the Staffordshire mills, where it is necessary that the roller should have a gas jet, or some similar light close to the rolls, but the incandescent or glow lamp system is found to answer admirably. The cost of maintenance, after allowing for the interest on capital outlay on plant, is only about half that of gas. The latest works at which the light has been adopted are the extensive steelworks of Messrs. John Lysaght, Limited, of the Swan Garden Ironworks, Wolverhampton. The whole of their works, including foundry, fitting shops, and offices, as well as pig yards, bar banks, and canal wharves, are well lighted up by means of the incandescent lamp. Recently the light has been required as much as 18 and 19 hours out of the 24, yet all has gone on well. For sheet rolls and shears the light is all that is required; for the stocktaker's examination it answers admirably; and for yards and wharves, though less brilliant than the arc lamp, it serves exceedingly well. The current is generated by two compound-wound dynamos, made by the Elwell-Parker Company, Wolverhampton. There are 380 lamps upon the two machines, 60 of them being single lamps of 95 volts, and 320 running in pairs at 48 volts. The dynamos are driven at 950 revolutions per minute by an ordinary high pressure horizontal engine, running at 90 revolutions, and supplied by steam at 40 lbs., raised by the waste heat from the heating and puddling furnaces. The plant has cost £616. At Messrs. E. T. Wright & Sons, Monmoor Ironworks, Wolverhampton, the system is also in use. One-half of the extensive works has thus been lighted up, and the installation is running as steadily now as the day it started. In this case the dynamo generating the current is, with a small engine to drive it, placed upon the top floor of the mill engine house, and the engineer of the turn looks after it without trouble. A third example is that at Messrs. George Wilkinson & Co.'s new sheet mill at Tividale. Here the dynamo is driven from the flywheel of a small engine which drives a pair of edging rolls for grinding, fettling, &c., and which the mill engineer also looks after. At these several works there is no provision for storing the electricity, nor has the need of it been felt. In several other large manufactories storage cells are employed, that the current may be used during the night which has been produced in the day. But in an ironworks storage is practically unnecessary. The steelworks at Bilston, of the Staffordshire Steel and Ingot Iron Company are also lighted up by electricity. The dynamo machines at all the works have been made by the Elwell-Parker Company, and the installations have been effected by Mr. G. B. Wright, of Wolverhampton, who has also lighted up the Varnish Works of Messrs. Mander Bros., of the same town, and the large galvanising works of Messrs. Walker Bros., of Walsall.

Electric Light for Scarf Pins.—We shall be glad if some of our readers will inform us which battery is considered best suited for use with the small incandescent lamps inserted in jewelry such as scarf pins.

Electric Lighting in the Turkish Navy.—A telegram from Constantinople announces that great activity is exhibited in the dockyard there, and that contracts are being made for the supply of electric lights.

Electric Lighting of Steamers. — The *Gascoyne*, a new Transatlantic liner, which has just been launched at La Seyne, near Toulon, and which will be the largest vessel of her kind in the French navy, is to be lighted by electricity.

Electric Lighting in the Straits Settlement.—*The Colonies and India* remarks that the introduction of the electric light into the Straits may now be accepted as an accomplished fact. Mr. E. J. Wells has exhibited the latest form of the incandescent lamp at his works in River Valley Road, and he was expecting the suitable machinery from England in order to exhibit the more powerful arc lamp. Mr. Wells is forming a company to be called the "Singapore and Straits Electric Light Company," for the purpose of furnishing the necessary capital to carry out the lighting of private dwelling-houses and public buildings in the Colony and the Native States on an extensive scale, and he has already obtained from the Municipal Commissioners a concession of the right to lay wires in one district of the town of Singapore. It is a curious circumstance that the same gentleman introduced gas into the Colony about 24 years ago.

Electric Light on the Purchase-Hire System.—In the cases of a large number of mills, factories, hotels, private houses and other buildings, although the adoption of the electric light would be a decided improvement and probably a saving of current expenditure as well, yet the owners do not feel justified in sinking the capital required for the purchase of the necessary machinery. With the view of meeting the requirements of those who are thus situated, the Anglo-American Brush Corporation has, very wisely we think, adopted the plan of supplying electrical plant on terms of deferred payments so as to enable those who desire it, to obtain all the requisites for an installation without immediately incurring a large capital outlay. The plan is to distribute the total cost of the plant over periods varying from one to three years, interest according to the period of hire being added to the net cash price of the machinery. Further particulars will be supplied to any applicant by the Secretary.

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Electric Lighting in Glasgow.—A special correspondent of the *Gas and Water Review* states that it has been resolved that the new Municipal Buildings of Glasgow, now in course of erection, and which will ultimately cost about half a million sterling, are to be illuminated with gas, and also partly with electric light. Provision is to be made, and pipes are to be laid, for lighting with gas throughout the entire buildings; but, in addition, the electric light is to be supplied to the Council hall, the banquetting hall and saloons adjoining, the telling rooms of the Gas and Water offices, the principal staircases and corridors, the saloons on the upper floors, the Lands Valuation office, and the quadrangle. The correspondent further remarks: "The electric light appears to give satisfaction at our various railway stations, but for the lighting of public works and offices it is not so popular in Glasgow, at least, as it was a year or two ago."

Electricity and Gas.—The gas lighting journals, or some of them, are adopting a more sensible attitude as regards the electric light than formerly characterised them, as will be gathered from the following remarks which we cull from last week's *Gas and Water*:—"Now, whatever may be our feelings or interests, we must admit that there are many purposes for which the electric light is better fitted than any other form of artificial light. For example, the magnificent nightly illuminations at the recent Inventions Exhibition could not have been equalled by any other means; and, for decorative purposes generally, the electric light stands unrivalled for beauty and possible diversities of application. In the lighting of hotels, theatres, public halls, shop windows, and other places where, notwithstanding extra cost, it pays as a means of advertisement, it has an extensive sphere for employment. Then, for many temporary purposes, where work has to be carried on at night, it is often the only form of light that would be practically available. Instances of this are to be seen at the Tay and the Forth bridges, and recently one was supplied in London, during the building of the new music hall opposite the Criterion. The above are facts, and it would be foolish to shut our eyes to them. The gas industry in future will have to face the electric light not as an erratic meteor, but as a sober and steady competitor. On former occasions we have duly chronicled the failures of the electric light, but it is equally our duty to record its progress when that is genuine. Although, as sensible men, we must accept accomplished facts, and forecast with such ability as we possess the probabilities of the future, there is little cause for discouragement. Notwithstanding the advances of the electric light for special purposes, the prospects of its introduction for ordinary use seems as remote as ever, and even the most sanguine electricians have ceased to predict its general adoption in lieu of gas. It is true that the position and prospects of the gas industry, in its lighting department, will be interfered with to some extent, but this loss will be more than counterbalanced by the profits arising from the extra sale of gas to be used for other purposes than lighting."

Progress of the Telephone.—In one of his current Lowell Institute Lectures, Mr. Thos. D. Lockwood gives some interesting figures in regard to telephonic industry and invention. The growth of the telephone is shown in the fact stated by him that, in August, 1877, the number of instruments in use in America was only 780, while in February, 1880, there was 60,800; 249,700 in 1883, 307,010 in 1884, and in February, 1885, 325,574. There are about 18,000 in Canada, and 13,000 in Great Britain. The number of exchanges in America has grown from 100 in 1880 to 782 in 1885, and in January of the present year there were 137,223 miles of telephone wire in the country. There are 5,168 persons furnished with employment by the exchanges. More different patents have been issued on the telephone than in any other single line of invention in the country. The total number for the ten years is 1,521.

Unauthorised Telephone Poles.—On Monday, at the Southwark County Court, his Honour Judge Holroyd and a jury were engaged in hearing a case in which Mr. William Wilcocks Oliver sued Mr. George Driver, manager of the British Telegraph Company, and Messrs. Burt, Boulton and Haywood, contractors, for £50 for wilful trespass upon the roof of plaintiff's premises, 15, Dockhead, Southwark, and placing thereon in 1881, telephone poles and wires without his knowledge or consent, and in so doing injuring the premises. The plaintiff, in the course of his examination, stated that his roof was very much injured, and he could not let the upper part of his premises for nearly four years, when he found that the defendants had caused the mischief through the General Post Office. The defendants practically admitted their trespass, and paid £9 into court, and evidence was given on both sides as to the extent of the plaintiff's loss. In the end the jury found a verdict for £20, inclusive of the sum paid into court. Costs were allowed.

Telephone Extensions in Scotland.—The Johnstone Town Council has had under consideration the application of the National Telephone Exchange Company for permission to erect poles to carry wires into the district. No objections being raised, the clerk was instructed to intimate the Board's concurrence. Arrangements, we learn, are all but complete for extending the telephone from Dumbarton to Helensburgh, and thence to St. Lord, Provost Ure's Mansion, Cairndhu. It may interest our readers to learn that it is 23 years since the telegraph was introduced to these towns by the British and Irish Magnetic Telegraph Company, under a five years' revenue guarantee.

The United Telephone Company.—When will the officials of this company see the error of their ways? Complaints as to defective service are constant, and amongst the most recent we quote the following editorial from the *Financial News*:—"The United Telephone Company seems to be completely upset by the severity of the weather. Complaints are heard on every side that subscribers are unable to communicate with each other, and the frequent ringing up of wrong numbers really makes the instruments a nuisance instead of a convenience. Considering the liberal pay that it receives, the United Telephone Company ought to manage to give a better service."

The Invention of the Quadruplex Telegraph.—The United States Commissioner of Patents has recently decided that the first and original inventor of the quadruplex system is not Thomas A. Edison, but one, Dr. Henry C. Nicholson, whose patent rights are held by the Western Union Telegraph Company. Had Edison's claims been maintained, the invention would have been open to the public, as in 1875, Edison took out a five years' patent in Canada, this circumstance rendering it for ever impossible for a valid patent to be issued to him in the United States covering the same ground. The patents have still to undergo the searching scrutiny of a court of equity, and it is expected that Mr. Edison will take a prominent part in the controversy; if they are adjudged valid, the Western Union Company secures a monopoly for seventeen years to come for what is described as one of the most profitable inventions of the present day.

Italian Telegraphs.—We have received a bulky volume containing statistics relating to the telegraphic service in Italy for the year 1884. Minute details appear to be given of the number of telegrams received at and transmitted from every office, whether the telegrams are private or government messages, the apparatus used at each office, and many other matters which are no doubt interesting to those concerned in the administration of the telegraph service.

Telegraph Revenue.—The receipts on the telegraphic service from April 1st, 1885, to January 16th, 1886, amounted to £,1,405,000, against £1,420,000 received from April 1st, 1884, to January 17th, 1885.

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How Tyarsome!—Mephistopheles had an unexpected delight at the Lyceum lately. Mr. Tyars, playing Valentine for the first time, says the *Weekly Dispatch*, forgot to attach the electric apparatus to the handle of his sword. The consequence was that in the duel with Faust every time his weapon was touched by that of Mephistopheles the current ran up his arm and playfully tickled his funnybone. This must have vastly amused the Devil, but Mr. Tyars cannot be prevailed upon to repeat the entertainment.

Another Fatal Accident.—Last Saturday's *Evening Standard* states that considerable sensation has been created in an American town by the accidental death of one man and the severe injuring of another from an electric shock. The two victims, both Italians, were standing together at the corner of a street, one of them leaning against an electric light pole. There was a flash of electricity, and instantaneously the man whose back was in contact with the pole dropped down dead at the feet of his companion. The latter stooped to pick up the dead man, but, as soon as his hand touched the body, he received a shock powerful enough to throw him to the ground, where he remained insensible until assistance came. On his recovery it was found that the hand that had been brought into contact with the body of his deceased friend was quite burned to a crisp, the injuries necessitating the immediate amputation of that member. Investigation showed that the man who lost his life had leaned against a hoisting wire running along the pole from the main wire to the ground; and his body becoming entangled in it, when he fell, the shock was communicated to his companion who stooped to raise him. The wire which brought about the double calamity was being strung throughout the town, and no current, says the American papers which relate the accident, had been turned on, there being no circuit. It is conjectured, therefore, that it was crossed by the wire of another company, and that in this way the current was produced.

The Transport of Accumulators.—It appears that in many instances accumulators, when sent to any distance, sustain more or less damage in transit. Cannot some safe method be devised and adopted in order to save complaints on this score? Or is damage during transport a term merely used to hide indifferent construction and workmanship?

Dynamo-Electric Machines.—The letter which we publish this week from the pen of Sir David Salomons is of an eminently practical nature. He appears to have hit the right nail on the head respecting the "economy per pound of copper." Certainly nobody would think of using incandescent lamps which are highly economical in electrical energy per candle-power, if their lives were not sufficiently long to justify their employment. Such facts as those contained in the communication to which we refer are of the greatest value, coming as they do from one who cannot possibly have any preference for any one manufacturer rather than another, except for the quality of his wares.

The Efficiency of Electro-motors.—Speaking of the performances of electro-motors, Mr. Mordey, in his paper on "The dynamo as a generator and as a motor," says:—"With electro-motors, on the other hand, one has to be contented with a much lower efficiency. The energy supplied to them is severely taxed in the process of conversion. Motors frequently yield, as mechanical energy in a useful and available form, only 30 per cent., and seldom more than 60 per cent. of the electric energy absorbed." Mr. Mordey is probably not aware that Mr. Reckenzaun's motors of ½ horse-power give an available return of 55 per cent.; one to two horse-power motors, 60 to 70 per cent., and larger ones 75 per cent.

Foreign Competition.—A capital leading article appeared in the *Daily Telegraph* of the 14th inst., on the depression of trade in England, and the increasing foreign competition with which we have to contend. The writer clearly established the fact that it is upon our own shoulders that the blame must be laid for such a state of affairs. As an instance of what can be produced abroad, we were shown last week, by a gentleman well known in the electrical profession, a trembling bell of the Rédon system, which could be sold here in quantities at a less price than our manufacturers could possibly produce it. The article was elegant and pleasing in appearance, well made, and ridiculously low in cost. If small articles can be manufactured on the Continent and sold in England at less than the cost of construction here, why not larger electrical goods? We also note that a well-accredited rumour comes from the other side of the Atlantic, that it is the intention of some wealthy and patriotic Americans to engage the premises at Philadelphia which have been occupied for many years by the celebrated John Roach, and to devote them to the uses of a joint-stock shipbuilding company. The projectors of this enterprise consider that the time is at hand when it will be possible to build iron ships of the highest class and largest size as cheaply and efficiently on the eastern seaboard of the United States as upon the Thames, the Clyde, the Tyne, the Mersey, the Tees, the Wear, or the Humber. At the present moment it is alleged that labour is but ten per cent. higher in Philadelphia than in this country; while, according to Mr. John Roach, "ten American artisans are equal to at least fourteen or fifteen Englishmen of the same class." He adds that skilled hands in the United States work quicker, more intelligently, and for more hours in the day, and, if necessary, in the night, than any of their congeners in the "Old Country." So that the best results will, in his opinion, follow from the establishment of a joint-stock company for building ships of the highest class. "Our iron and steel," says this veteran employer of labour, "are far better than those produced in England; we have coal to an unlimited extent and at the cheapest rates; and all that we want is skilled supervision."

Electric Alarms in Railway Carriages.—In response to enquiries, provoked by the recent murder of a Prefect in a railway carriage near Paris, the French Minister of Public Works stated that the railway companies had been repeatedly pressed to take precautions for greater security in railway travelling, and all but the Orleans Company had now electric alarms. M. Delattré urged the futility of the electric alarms if sleeping passengers were attacked; and he quoted a colleague's remark that, had a Minister been murdered instead of a Prefect, the compartment system would be at an end in six months.

The Edison Telephone Patents in Canada.—We understand that in an action brought by the Telephone Manufacturing Company of Toronto against the Bell Telephone Company of Canada to set aside the three patents granted to Mr. T. A. Edison in Canada, for alleged forfeiture on the grounds of *non-manufacturing* and *importing* in the terms of section 28 of the Canadian Patent Act, the Minister of Agriculture has decided in favour of the Bell Company and upheld the patents.

A Warning.—A fellow, giving the name of Watson, is prowling about amongst engineers' offices, at which he calls to inform the occupier thereof that the Deputy-Manager of the Albert Docks Railway Company, whose correct name he gives, wishes to see him the next morning on professional business. Before leaving he makes some pretext to ask for money which, in some instances, he may receive. We need scarcely say that the company knows nothing whatever of the man, so if he should favour any of our readers with a call they would act wisely in detaining him for enquiries into his antecedents.

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Power Required for the Elevated Railways.—Mr. Frank J. Sprague makes the following communication to the New York *Electrician and Electrical Engineer*: "'It would be very difficult for an outsider, not an electrician, to form any idea of the feasibility or probable economy of propelling the elevated railroad trains by electricity, unless he had given that subject and particular problem a great deal of attention and calculation.' I quote the above from an article in the March number of the *Electrician and Electrical Engineer*, by Charles G. Curtis. It is not my intention to enter into any discussion of this article generally. I should be inclined to make no reference to it nor to the 'corrected figures' appearing in the May issue, had Mr. Curtis let bad enough alone and not plumed himself on his accuracy by reference in the November number to Mr. Sinclair's valuable experiments. It is time that his manifold errors on work done by the elevated road engines were pointed out. The first article represents the engine as having nothing to do but ordinary traction at a mean speed of 12·5 miles per hour, gives a mean power of 23 horses, and a net consumption of 19 lbs. of coal per horse-power hour. The next article corrects this by taking into account the work expended in raising the train to its full speed, increases the engine power to 75 horses, and reduces the expenditure to 6·6 lbs. of coal per horse-power hour. In Mr. Curtis's last letter he 'refers to it (Sinclair's work) because it is so satisfactory a verification of the results arrived at by a theoretical mechanical calculation,' &c. Allow me to present a few facts for Mr. Curtis's consideration. The work done on the elevated roads is expended in three, not two, ways; overcoming the inertia of the train, lifting it bodily from the level of low to that of higher grades, and traction. The proportions of work are very nearly as follows:—Overcoming inertia, 59 per cent.; lifting, 24 per cent.; traction, 17 per cent. Mr. Curtis lost sight of the grades of this road, which require that a train be lifted bodily an aggregate of 282 feet in one round trip. The work so done is half as much again that expended in traction. The average net horse-power distributed over the entire time of a trip is about 69 H.P. The actual engine capacity is about 185 H.P. per minute. The mean running speed between stations is 14·7 miles. Mr. Curtis's agreement with Mr. Sinclair is purely accidental, caused by getting his average maximum speed too high, leaving out the work of lifting, about a quarter of the whole, and the element of engine or motor friction. Some papers will be made public in a few days which will give the methods of getting the above results, and also answering some of Mr. Curtis's queries, why and how shall the elevated roads be operated by electricity? One of those answers is that the capacity of the roads must be increased independent of the saving in coal expense, although this is perfectly practicable. 'I, for one electrician,' and one whose faith in the future of electric propulsion is not so easily shaken, will be glad to soon show Mr. Curtis how this is to be done."

Overhead Wires and Snowstorms.—The following letter has been received by a gentleman who pointed out to the Postmaster-General that serious loss is incurred by the commercial community through the breakdown of telegraph wires by snowstorms, &c., and inquired whether the department contemplated an established system of underground wires, similar to those now in use in the German Empire:—"General Post Office, London, January 15th. Sir,—I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 12th inst., and to inform you in reply that this department has already placed a very large number of wires underground in and around London and in and around the principal towns in the United Kingdom. More works of this kind will be carried out from time to time as opportunity offers, but the Postmaster-General cannot hold out a hope that the telegraph wires throughout the country will be placed underground.—I am, Sir, your obedient servant, C. H. PATEY."

The Dynamo Tests at Philadelphia.—Speaking of these tests, to which we have several times alluded, and respecting which we published the report of the committee of the Franklin Institute on November 21st, 1885, and subsequently, the American *Electrician and Electrical Engineer* says:—"The character and ability of the gentlemen composing the committee are such, and the facilities at their command have been so unusual, that the results, as a whole, may be regarded as of greater practical value than any which have hitherto been rendered accessible to the public."

Motor-Armatures without Iron!—M. Hospitalier, in commenting upon the paper of Mr. Mordey, published in our issue of the 8th inst., concludes thus:—Does it not result from the interesting study made by Mr. Mordey, that it would be possible to make motors without iron in the armature, as they make the generators such as Siemens, Ferranti, Bollmann, &c. The cause of loss pointed out by Messrs. Mordey & Watson would thus be removed, and we should be placed in the theoretical conditions, indicated at the beginning, of an intense magnetic field acting upon conductors traversed by a current. We should be glad to know the results of experiments made in this direction.

Electric Locomotion.—This subject is now attracting some attention in the United States, and in the January issue of the New York *Electrician and Electrical Engineer* Mr. Frank C. Lockwood has an article pointing out the dangers to which travellers on the cable trams which cross the East River Bridge are subject, and the advantages of an electric system of propulsion.

The British Association.—The meeting of the British Association to be held at Birmingham, beginning on Wednesday, September 1st, will derive more than usual interest and importance from the exhibition of local manufactures which is to be held in connection with it. The Association has met three times previously in Birmingham, in 1838, 1849, and 1865. On each occasion an exhibition of local manufactures was held, and it is an interesting fact to record that to the example of the first of these are due all international and other exhibitions since conducted on so large a scale. The exhibition of 1838 was the first industrial exhibition in the country. The Prince Consort visited the one in 1849, and it suggested to him the idea of the International Exhibition of 1851. The exhibition which is to be held on the forthcoming occasion will be on a very much larger scale and of a much more popular and attractive character than has ever been attempted before. It is to be an exhibition illustrative of products and processes connected with the manufacturing industries of Birmingham and the surrounding district within a radius of 15 miles, which will include the whole of the Black Country, the nail district, and other towns where manufactures are carried on. The exhibition will be on a very complete scale, and will embrace as nearly as possible all the industries of the district, which will include the following:—Engineering, hardware, heating and lighting, arms and ammunition, jewelry, glass and pottery, stationery, leather, furniture and decoration, and a miscellaneous class, including scientific and musical instruments. The special feature of the undertaking will be that in every trade represented processes will be either completely shown or fully indicated. Workmen will be seen engaged in carrying out most interesting or difficult operations connected with various industries. The exhibition will be opened on August 26th, and close on October 1st, three weeks after the termination of the visit of the Association. Arrangements are being made with the railway companies to facilitate the arrival and departure of excursionists. High-class musical entertainments will be provided, and the best known bands in London will be engaged. Excursions to places of interest will be arranged.

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Some Electrical Work in 1885.—During the past year, Messrs. J. D. F. Andrews & Co. have completed a large number of installations, of some of which descriptions have already appeared in our columns. Amongst others we may mention the following:—The Cunard Steamship Company's *Umbria* and *Etruria*, 850 glow lamps and two arc lamps each; H.M.S. *Ajax*, 290 glow lamps; H.M.S. *Conqueror*, 160 glow lamps; ss. *Corangamite* and *Burrambeet*, belonging to Messrs. Huddant, Parker & Co., of Melbourne, 160 lights each; Captain Parker's steam yacht *Lady Beatrice*, 35 lights; Messrs. R. & J. Dick's boot shop, High Holborn, London, 70 lights; Messrs. Simons & Co.'s dredger *Melbourne*, 6 arc lamps, &c., &c.

It may be of interest to those who have read our descriptions of some of these installations, to learn that they are giving entire satisfaction, and that they have not given the slightest trouble since they were completed. The firm had its apparatus on exhibition for the first time at the International Inventions Exhibition. It has during the year supplied a number of Andrews dynamos and other apparatus through agents and on its own installations, and during the last few months has largely increased the facilities for turning out these machines quickly, in order to keep pace with the increasing demand. The firm has also recently made some very material improvements in the Andrews arc lamp, and has obtained some excellent results from the trials that have been made.

The company has booked some pretty considerable orders during the last months of the year, amongst which we may mention Messrs. Geo. Smith & Son's ss. *City of Bombay*, which it has just lighted with 110 lights and a duplicate set of machinery; a block of mills at Lancaster, amounting in all to about 500 lights, the lighting of three large passenger steamers for the North German Lloyd, with about 450 lights each, an installation of arc lamps in Mr. Houghton's steel works at Carnforth, another arc installation in a paper mill at Leslie, &c., &c. The company has also a number of orders for the Andrews dynamos and arc lamps, and has every prospect of more business in the year upon which we are just entering than in the past year.

Transmission Dynamometers.—We publish in another column a letter from Mr. C. F. Heinrichs, in which he gives his reasons for doubting the accuracy of the recent dynamo tests in Philadelphia. We think it highly probable that there is some truth in Mr. Heinrichs's criticisms.

Electric Fire Alarms.—At a recent meeting of the Glasgow Town Council it was mentioned that the street fire alarms had been the means of conveying 163 alarms of fire, and only failed on three occasions to transmit an alarm when required. As the new alarms were nearly completed, Mr. Paterson was sanguine that the number of false alarms will be diminished, and that they will prove more reliable than the old ones.

Electric Lighting at Taunton.—On Monday evening, last week, Mr. C. J. Wharton, of the firm of Laing, Wharton and Down, electric light engineers, Holborn Viaduct, who are the suppliers of the light with which the main street of Taunton and some of its principal business houses have been served during the past month, delivered a lecture in the Victoria Rooms on "Electric Lighting." The interest manifested in the subject was proved by the large attendance, the hall being crowded, and the Mayor, Mr. T. Penny, presiding. Mr. Wharton in the course of his lecture said that there were at that moment about 100 companies in the States using the Thomson-Houston system, and most of them were making a profit of 10 or 12 per cent., the lowest being 8 per cent. On the 1st October, 1883, there were 1,653 Thomson-Houston lamps in the various cities, and on the 1st October, 1885, there were 16,475. The local companies had gone up from 22 to 102. In most instances the old companies had trebled the number of lamps with which they originally started, and that increase of business was a much healthier sign than the increase in the number of companies. The Thomson-Houston lamps exhibited at the Inventories gained the gold medal in spite of the strong opposition of other companies, the most formidable of which—the Brush—was awarded the bronze medal. Having done that his firm started to push the system in this country, but he regretted to say business was very slack indeed. There was no such enterprise as the Americans possessed. The Americans were not rush-ahead people, they were on the other hand very 'cute, calculating people; but they went thoroughly into a matter, and if they saw a chance of making it pay they adopted it. He, the lecturer, was doing better business on the Continent than in England. When he introduced the Thomson-Houston system on this side of the channel, he arranged for the plant to be supplied at 25 per cent. less than was obtained for it in America and on the Continent, and notwithstanding that he had not secured an order from any town in England.

As the result of a month's trial of the Thomson-Houston system, the principal tradesmen of Taunton have held a public meeting, for the purpose of considering the desirability of retaining the light in permanence for public and domestic use, by establishing a limited liability company to supply it. Mr. Massingham, of Bath, Taunton, and Torquay, to whose efforts the introduction of the electric light in Taunton is mainly due, explained its cost. He said each arc light on an average would cost £15 a year. The capital required he estimated at about £5,000, which would be sufficient to erect machinery to supply 120 arc lights; £3,000 had already been found. A resolution in favour of adopting the light was unanimously carried.

Earth Currents.—At the ordinary meeting of the Royal Society, Edinburgh, held on Monday night, Prof. Chrystal read a paper by Mr. H. N. Dickson, on Earth Currents in the Ben Nevis Observatory Telegraph Cable. On account of the frequent disturbance of telegraphic instruments at the observatory by earth currents, the inference was drawn that these currents always existed with more or less strength, and a series of observations, extending from the middle of September to the middle of October, 1885, was taken to determine, if possible, how far these disturbances were regular. Observations were taken hourly by means of a galvanometer inserted in the telegraphic circuit, from which it appeared that from midnight till 4 a.m. there was an earth current passing up the hill, and reaching its first maximum about 2 a.m. There was then a slight return current down the line till about five. At that time a strong current up the line set in, reaching the maximum for the day at 10 a.m., and its minimum at 1 p.m. After that the current increased pretty rapidly down the line again till 3 p.m., when it was rather unsteady till 8 p.m. An uphill current set in again steadily, increasing till 9, and reaching a minimum at 11. During the time when these observations were taken the summit of Ben Nevis was almost continuously enveloped in storm and mist, which necessarily affected the result. It was observed that when the top of Ben Nevis was clear there was a strong current coming up the line. Otherwise the current was reversed. During a fall of snow the current was observed to be down the line. Professor Chrystal said these results opened up an interesting field in electrical science which could only be thoroughly investigated by help from Government. One thing required would be to obtain possession of a land line to make experiments as to the effect of earth currents along the horizontal.

Electric Lighting on Yachts.—Mr. John Clark, of the Anchor Mills, Paisley, left Largs, on Monday evening, in his steam yacht *Mohican*, for a three months' cruise in the Mediterranean. The *Mohican*, which is the only steam yacht from the Clyde that will winter in the Mediterranean this year, has been fitted with the

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electric light in all her cabins, and in the officers' and crews' quarters, the total number of lamps being 78, besides which there is a large "search lamp" fitted on deck.

The Reis Telephone.—Our readers will peruse with pleasure the opinions, which we publish this week, of eminent American scientists upon the invention of Phillip Reis.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Northern District Telephone Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 12th inst. The nominal capital is £100,000 divided into 15,000 ordinary shares of £5 each and 2,500 preference shares of £10 each. 2,076 preference shares have been taken up, the calls received thereupon amounting to £17,810 16s. 4d., leaving £324 3s. 8d. unpaid. As compared with the previous return, the paid-up capital shows an increase of £7,247 16s. 4d.

W. T. Henley's Electric Light and Power Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 12th inst. The nominal capital is £100,000 in £1 shares. 6,868 shares have been taken up and the full amount has been called thereon. The calls paid amount to £6,828, leaving £40 unpaid. The sum of £41 10s. 11d. has been paid upon 101 shares forfeited. As compared with the previous return, the paid-up capital has been increased by £3,821.

United Telephone Company of the River Plate, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 15th inst. The nominal capital is £200,000 in £5 shares. 20,397 shares have been taken up and the full amount has been called thereon, the calls paid amounting to £101,980; the paid-up capital thus exceeding by £700 the amount recorded as paid up in the previous return.

William Elmore, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 13th inst. The nominal capital is £240,000 divided into 16,000 A and 8,000 B shares of £10 each; 3,909 A and the whole of the B shares have been taken up and the full amount has been called thereon. The calls received amount to £38,160, leaving £930 unpaid, and £80,000 is considered as paid upon the B shares. As compared with the previous return there is an increase of £72,705 in the paid-up capital.

Continental Etevè Engine Company, Limited.—The registered office of this company is situate at 15, New Broad Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim Weston Electric Company, Limited.

AN extraordinary general meeting of this company was held last Friday at the City Terminus Hotel, Cannon Street, to consider two resolutions for reducing the capital of the company. Mr. Hugh Watt, M.P., presided. The Chairman in moving the first resolution, which was for reducing the capital by £62,500 by cancelling paid-up capital unrepresented by available assets (being patents over-estimated in value) to the extent of 5s. a share on each of the 250,000 shares issued, referred at some length to the past history of the company, and went on to to say that in purchasing the Maxim and Weston patents the company had been able to carry on a legitimate business; but, having paid between £50,000 and £60,000 for them, he thought that provision ought to have been made by which the company could obtain in the future plant from the United States Company at a much less cost than ordinary purchasers. He was glad to state that the management of that company in America had met him so far in a very handsome way, on the representations which he had made to them. On the working of the past 21 months they showed a handsome profit, and for the past year they would show, when the accounts were presented, a good profit, enabling them to declare a dividend in the event of the proposed resolutions being agreed to. During the past year the working purposes of the company had necessitated the issue of 50,000 shares, which the proprietors sanctioned in May, 1884. That capital had been placed, the limit given to the directors being 5s. a share. There was consequently a large deficit, and he was advised by their solicitor and counsel that it would be impossible to declare a dividend until the capital had been reduced to the present price of issue. Two years and nine months ago they sanctioned the issue of 27,500 shares at 5s., and the old shareholders thought that was no inducement to them even to save their property. He had been very much pressed during the last year by shareholders who desired a dividend, and if the directors could have declared one without "cutting" the capital he would not have troubled the shareholders that day. It had, however, been decided by the High Court of Justice that a dividend could not be declared unless the capital were intact. The shareholders had twice sanctioned the issue of shares at 5s. each. Of course, the directors would not have issued that capital had it been possible for them to go on without it, but all the working capital they had, after paying the debts of the old company, was £2,500. Some of the old original patents had expired, and therefore, during the past year, while they had done considerably more business than in the previous year, they had probably not made a larger profit, as they had had to meet the market in price. The directors did not wish to press the resolutions if the shareholders did not desire a dividend; but, after all, the reduction of capital would be effected by writing down the patents account. It would therefore not affect the intrinsic value of their property, though he did not say it would not affect its market price.

Mr. Swabey (a director), in seconding the resolution, observed that if he could have his way he would go further than was now proposed. He would not only reduce the shares to 5s., but would afterwards convert them again into £1 shares by exchanging four shares of 5s. for one share of £1.

Mr. Thomas objected to the resolution. In March, 1884, he said, they wrote off for depreciation of the patents £43,067.

Mr. Griffith said he altogether took exception to the law as laid down, that dividends could not be paid in existing circumstances; but apart from that there were other objections to the resolution. The shares had already been written down to 10s. from £1.

Mr. Russell proposed an amendment postponing the consideration of the matter until the accounts for the year had been presented.

The Chairman, in reply, said he was satisfied, having examined the judgments which had been delivered, that a dividend could not be declared in the present position of the company without personal liability attaching to the directors (a view subsequently endorsed by Mr. John Newton). On the 31st December last the company had about £12,000 at the bank, some £12,000 was owing to them—about one-third being due from the British or Colonial Governments—and they owed about £300 or £400. In reply to further questions, he stated that they had greatly improved on the Maxim and Weston patents. If the resolution were not passed it would virtually mean no dividend for two years. There was no power at present to issue any more shares, but possibly at the general meeting he might ask them to authorise the directors to issue, as and when required, a further 50,000 shares. If so, however, it would be in connection with a matter which would place the company on a very different footing.

Ultimately the amendment was withdrawn, and the resolution was then passed.

The Chairman then moved, and Mr. John Brown seconded, a resolution which was afterwards passed, further reducing the capital by £62,500 by reducing the nominal amount of the remaining 250,000 shares from 10s. to 5s., "thereby leaving the nominal capital of the company £125,000, divided into 500,000 shares of 5s. each."

This terminated the proceedings.

German Union Telegraph Company, Limited.—Payment was made on the 8th inst. of the dividend of 16s. 6d. per share (coupon No. 4) on the 5½ per cent. original preference shares of £15, or 300 marks each, at the office of the London Agency, Winchester House, 50, Old Broad Street, E.C. Payment was also made of a dividend of 12 marks, or 11s. 9d. per share (coupon No. 5) on the original shares of 100 thalers, or £15 each.

Globe Telegraph and Trust Company, Limited.—The payment is announced of an interim dividend on and after the 18th inst. of 3s. per share on the preference shares, less income-tax, and of 1s. 6d. per share on the ordinary shares, free of income-tax, for the quarter ending 18th January next.

Western Union Telegraph Company, Limited.—Messrs. Morton, Rose and Co. announce the numbers of the Six per Cent. Sterling Loan of this company, drawn for payment on March 1st.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 15th were £2,429, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th January are £2,685, as compared with £2,024 in the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended January 15th were £3,147.

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NEW PATENTS—1886.

523. "Automatic electric fire alarms." J. W. SMITH. Dated January 13.

532. "Machine for increasing the utility of the telephone and telegraph to the general public." G. J. RHODES. Dated January 13.

584. "Telephone apparatus." S. A. EDWARDS. Dated January 14.

611. "Secondary voltaic battery." O. IMRAY. (Communicated by A. Khotinsky.) Dated January 14.

615. "Dynamo-electric machines." W. GRIERSON. Dated January 14.

621. "Galvanic batteries." F. H. VARLEY, VARLEY ELECTRIC PATENTS PROPRIETORY. Dated January 14.

639. "Erecting overhead telegraphic, telephonic and similar wires." J. POOLE, K. MACIVER. Dated January 15.

654. "Apparatus for electric lamps." H. DEFTY. Dated January 15.

668. "Electric telegraph receiving instruments." F. H. W. HIGGINS. Dated January 15.

723. "Electro field-magnets for dynamo-electric machines, &c." R. KENNEDY. Dated January 16.

741. "Arc electric lamps." T. STANLEY, A. H. DAVIES, C. RICHARDSON. Dated January 18.

769. "Arc lamps." J. H. HOLMES. Dated January 18.

771. "Generating or utilising electricity." H. EDMUNDS, W. T. GOOLDEN. Dated January 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

800. "Improvements in the treatment of sulphides in alkaline solutions by electrolysis." H. W. DEACON, F. HURTER, and W. ELMORE. Dated January 20. 6d. Consists in passing through solutions containing alkaline sulphides a current of electricity so that the sulphides contained in the said solutions may be decomposed by the current in such manner either that the sulphur is deposited upon the anode, hydrogen being evolved at the kathode, or that a portion or practically all of the sulphur is oxidised at the anode, hydrogen being evolved at the kathode.

1088. "Improvements in galvanic or primary batteries." C. M. NEWTON. Dated January 26. 8d. The negative pole of the battery is constituted by a metal capable of being attacked by the exciting fluid or liquid of the pile or battery when the circuit is closed, for example, zinc, tin, lead, copper, or any metal of like nature and properties. The positive pole is formed by a plate or plates of iron, copper, lead, or other metal, which are allowed to dip into, or are placed in contact with, a quantity of oxide of lead or litharge, or else it is formed by the containing vessel or cell being made of wrought or cast iron (or copper, lead, or other metal), and a quantity of oxide of lead or litharge at the bottom and sides as a depolariser.

1183. "Improvements in mechanical telegraphs and indicators suitable for use on ship board, and in other places." H. BOTTEN. Dated January 27. 8d. The improved telegraph and indicator is adapted to transmit a limited number of definite orders and the acknowledgments of or replies to such orders; such communication, in short, as it is necessary to carry on between the bridge of a steamer and the engine room.

1234. "Improvements in electrical signalling and recording apparatus, applicable for use on railways." J. ENRIGHT. Dated January 28. 8d. The objects in view are the transmission to railway trains of the signals necessary to regulate their movements, and to ensure a record of such signals; an especial feature of the present invention being that the stop or "danger" signal shall be given to the train by disconnecting the station battery from the line wire whilst the safety signal is given by the passage of the current in the line wire.

1764. "Improvements in secondary batteries." J. S. SELLON. Dated February 9. 8d. The inventor arranges the plates so that the elements or plates of one pole may be transverse to the elements or plates of the other pole.

1853. "Improvements in dynamo-electric machines." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. Has for its object the transformation into electricity of as much as possible of the mechanical work consumed on the machine shaft, the arrangement being such that the production of extra currents, sparks, and friction in the bearings and contact brushes are obviated as much as possible. Besides the improved effect, the further advantage is attained that the iron masses of the machine working as magnets are not heated by so-called Foucault's currents.

13279. "Improvements in insulators for telegraph wires and the like." W. P. THOMPSON. (Communicated from abroad by E. A. Müller, of Germany.) Dated November 3. 6d. As shown in Figures 1. and 2, the insulator has a perpendicular slit, *s*, cut into it from above, dividing its head into two segments; each of these segments has a piece cut out of it horizontally, somewhat deeper than to its centre, and these two horizontal cuts are in opposite directions, each segment consequently assumes the shape

FIG. 1.

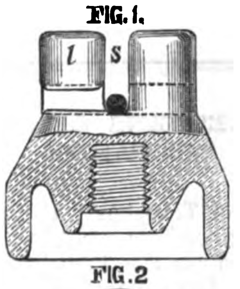
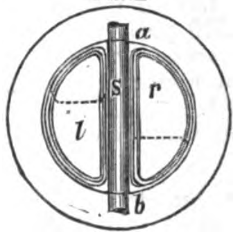


FIG. 2



of a hook, one turned in one direction, and the other in the other, as shown in the drawings at *l* and *r*. In order to secure the telegraph line *a*, *b*, in the insulator, the line is inserted in the vertical slit, *s*, and the insulator is rotated a quarter turn towards the left, whereon the hooks *l* and *r* clasp the line.

CORRESPONDENCE.

Dynamos and Domestic Electric Lighting.

Electrical facts from impartial observers are the most valuable, if truthfully recorded. Having used my best endeavours to obtain reliable results, and standing on neutral ground, the following may be acceptable for publication. My object is not to *puff* any particular maker, but to indicate the lines on which future improvement should advance. Many Siemens machines have passed through my hands, and the last was made the end of 1884. Although these machines gave good results when worked near their maximum, their efficiency was very bad when small currents were taken off. This firm has "marched with the times," and I therefore give the date to avoid being unfair. Crompton's machines have a good efficiency, but I have had endless trouble with the bearings and brushes, due to the great length of the bearings and high speed. The difficulty of oiling long bearings is very great, and if the speed gets the better of the oil for a moment, it is all over, and the bearing gets very warm, and consequently the commutator also. Thus constant watch must be kept on these dynamos, and even then they are troublesome. The work is excellent otherwise. Mr. Crompton, recognising these difficulties, has been good enough to improve and exchange my machines, and I have little doubt that the difficulty here mentioned will disappear. I consider that unless a dynamo may be left without anxiety for five or six hours it is not a practical machine, and no possible harm should occur by being left to itself for 10 or 12 hours. Elwell-Parker's machines have also failed in my requirements till quite recently. This firm has built several dynamos for me, and at last a machine has been produced such that a better one cannot be wished for. The requirements of the machine were all specified by me, and Messrs. Elwell-Parker had to build a special size (not in their list) to meet the case.

The reason for success is greatly due to total disregard for "economy per pound of copper, &c.," which is, to my mind, great nonsense, because, to compare such re-

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sults with a steam engine, it would mean that makers would struggle with one another to turn out an engine to do a certain work with the least possible quantity of metal in it, and thus the slightest extra strain would cause a breakdown. This is what dynamo manufacturers are aiming at now, and the public imagine that "economy per pound of copper" means something very good. It really means most profit in the manufacturer's pocket, for I do not find that such machines are sold cheaper in comparison with others. Considering the expense of dynamos, £5 more or less is a small matter in the cost, but a large item in its lasting powers. Let me ask, Why do the "Pound wise" people go to the best engine makers and pay about double for an engine of a certain nominal H.P., which might have been bought for the half from some other firm? It is because they are better made, less easily strained, and more lasting. Yet the same "Pound wise" do not see things in the same light when it comes to a dynamo. It is the "per pound of copper efficiency" which blinds them. They do not say "per pound of iron and steam efficiency" in a steam engine. These remarks may appear hard but they are true enough. I must not be misunderstood to mean that the more copper the better the dynamo. I mean that in a good and well designed dynamo the weight of copper should be quite a secondary thing; efficiency comes first; first cost and weight are small matters compared with daily waste of coal and oil. For tramcar work, of course, weight is an important factor, but I am not treating of these machines. Now to describe the last machine supplied to me by Messrs. Elwell-Parker. It is vertical and would be called about a 30 unit size. Armature, 16 inches diameter, by 24 inches long. It is a 4-pole machine, 5 feet 9 inches high. At 400 revolutions 100 ampères may be taken at 130 volts (I have not yet tried larger currents from it). The machine will give 250 ampères, and may be run up to 800 revolutions per minute, so that its capabilities are very great. For my special purposes resistances are put into the F.M. circuit (being simple shunt), and I find not the *trace* of sparking, no matter what current is being taken off, or what resistance is put in. For experiments, resistances were inserted reducing the 130 volts down to 10 or 12 volts, and yet no sparking occurred. The field-magnet coils are as cool after 12 hours' run as at the start, no perceptible rise in temperature. About 3 to 4 ampères pass these coils in practice. The commutator is greased at starting, and not touched all day. The brushes only just bear on the commutator, and do not press heavily. By the construction of the machine, the ventilation is very good, and four pole machines are peculiarly adapted to this end. The bearings are greased with cups of solid grease pressed down by a piston, and so excellent is the lubrication that the machine has run 201 hours 55 minutes for an amount of grease weighing perhaps ½ oz. For since the last filling (over 200 running hours ago), the pistons have to the eye scarcely descended. Each bearing has two cups, holding about 1 oz. of grease in each, and they run *absolutely* cool. The dynamo weighs about 3 tons 6 cwt., and is remarkably steady when simply standing on the ground. Undoubtedly a large number of careful tests for efficiency have been made. The manufacturers place it at 95 per cent. My own experiments show 96 per cent. at best, and 90 per cent. at worst. By the latter I mean when only small currents are taken from it.

Result by comparison with other machines

After about 40 days' trial is as follows—two per cent. more E.M.F. and 10 per cent. more current were used, than with the other machines, and yet 20 per cent. less coal, thus my total saving is 32 per cent., say 30 per cent. This practical test is the best after all, for we use more lamp hours now, in the short days, run shorter time, and use far less coal. The dynamo is not well constructed for "economy per pound of copper," but what do I care when the saving is at least 14s. a week by its economy, or 2s. a day on average?

As was said at the start, it is not my object to advertise any particular firm, but to show what appears to me the proper development of dynamos in future. The points may be summed up:—

1. Slow speed.
2. Bearings not too long, and lubrication which shall not fail.
3. Plenty of copper to keep all parts cool.

No doubt many would like to know the cost of this dynamo. The price I am not at liberty to mention, because it was a special one, and far lower than could be made for general sale, which arose from the fact that the makers undertook to supply a machine at a price which was found impossible when experiments were made. I therefore must leave the publication of the list price to the manufacturers themselves, as I do not know it myself.

Let me incidentally add that the total cost of the installation here, as compared with gas, for 1885 has been four-fold; every possible charge having been allowed for, including sinking fund, but exclusive of interest. The installation has not been fairly used (through domestic events and electioneering) last year, that is to say, the average of lamps used nightly has been under 40 in an installation in duplicate for 400 to 500 lamps, or in all 1,000 lamps, so in reality the result is certainly good. If the nightly average of lamps had been about 100, gas would have been dearer than the electric light.

The importance of this communication must plead the apology for its length.

Before concluding I must pay a high tribute to Mr. Ferranti's current meter, which has shown many errors into which we had fallen, by estimating the current used over long periods by old methods.

David Salomons.

Broomhill, Tunbridge Wells,
January 18th, 1886.

American Telephone Patents.

Your editorial of October 31st, 1885, on American Telephone Patents, comes to this side in the midst of the most extensive presentation of facts on ex parte affidavits that has yet been made for the purpose of filing a Bill in the name of the United States, with the end in view of testing the validity of the Bell patent of 1876, on the ground of misrepresentation and fraud, whether legal or actual, or by acts of omission or commission on the part of the applicant or the Patent Office. Your criticism may be entirely just and proper as applied to the particular company at whose request the former suit was authorised by the Department of Justice, but in view of the public opinion existing in the United States, it will be very unwise and impolitic for the present administration to decline to commence the proceedings based on the ex parte evidence, unless such a proceeding be contrary to express warrant of law by a statute, decision, or general construction. You, of course, understand that the grievance and complaint on the part of the public in the United States as against the Bell monopoly is vastly different from that which the English public have had to contend with as the result of litigation on the English branch of the Bell patents. In the United States the *bête noir* of the Bell monopoly is the unwarranted extent and broad construction given by the inferior courts to the fifth claim of Bell's patent of 1876, of multiple telegraphy, as covering a broad claim to the method or process of reproducing articulate speech by electricity without regard to the form of the apparatus, namely transmitter or receiver. In view of the present knowledge of the actual and precise history of the state of the art at the time this broad claim was granted, it is a subject matter of wonderment and amazement that any man could pose before the world for nine years as the discoverer of a method or process of reproducing articulate speech without having such a preposterous broad claim passed upon and decided by the highest appellate court of justice in the land. Such a state of facts has only been possible in the United States, the owners of this patent knowing the inherent weakness of their position on the broad claim,

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by the enormous expenditure of money in the retention of the most expert and eminent lawyers in the land for the purpose of stifling an ultimate decision by delay or compromise in order to continue their oppressive monopoly. It is a fact beyond contradiction or cavil that at the present time, more than nine years have elapsed since the grant of the broad claim in the Bell patent of March 7th, 1876, and yet no case has been permitted to come before the Supreme Court of the United States for argument, and that the only case now upon the calendar of that court for argument is the Dolbear case, in which there is an admission of Bell's prior invention under the hope of establishing a distinction on the Dolbear receiver, known as the condenser. This case, coming as it does from Massachusetts, based upon such admissions and upon evidence taken in the then knowledge of the state of the art, is by no means such a case as should control the decision of the broad question in which the public in the United States is so deeply interested.

Without wishing to anticipate the action of the Secretary of the Interior on the facts and arguments which are now being presented to him on the various interests opposed to the Bell monopoly, it will readily be seen from the above how vastly important it is that such a suit should be authorized and instituted if there be any precedent therefor, so that a full presentation of all the facts and evidence in the control of the various opposing interests may be harmonised and crystallised into one proceeding, which, on account of its great public bearing shall have precedence of other cases, not only for the purpose of ending vexatious suits and litigation in all parts of the United States, but to settle at once and for ever the question as to whether the American Bell Telephone Company shall have the right to enrich a few men at the expense of the masses, and absolutely to prevent all competition and improvement in one of the greatest discoveries of any age.

Jerome Carty.

Philadelphia, *November 12th*, 1885.

[The dispatch of this letter from America must have been by some means greatly delayed. That the delay was not caused on this side is evident from the fact that the Philadelphia post mark is dated January, 1886. —EDS. ELEC. REV.]

Domestic Electric Lighting.

The following particulars of an installation I have just put to work to light the shop and show room of Messrs. Wm. Egan & Sons, jewellers, of this city, may be of interest, as they more than bear out the statements of Mr. J. H. Greenhill in your two last issues as to the work to be got out of the $\frac{1}{2}$ H.P. Crossley gas engine. The installation at present consists of 25 Swan lamps, 20 and 10 candle-power; 26 E.P.S. cells, 17 S type, one modified Gramme armature dynamo, which I have designed and built specially for this installation, and a $\frac{1}{2}$ H.P. Otto gas engine as motor. On the first night that the engine and dynamo were run (the accumulators were not used) it was found easy to light to their full incandescence 11 Swan 20 C.P. 52 volt lamps, and one 50 C.P. 50 volt (this latter being a little overworked), or equal to 13·5 of the 20 C.P. lamps. The consumption of gas was taken simultaneously, and was 54 feet per hour, from which it will be seen that Mr. Greenhill has rather under-stated the power to be obtained from an Otto $\frac{1}{2}$-horse engine. The consumption of Cork gas is about 10 to 12 feet per hour more than of Belfast, but the light obtained is greater per unit of gas consumed by about 7 to 9 per cent.; this result is doubtless due to the high resistance of the shunt wire used to excite the field magnets of the dynamo, which are of wrought iron with laminated pole-pieces, and to the low resistance of the armature, whereby a considerable economy in the production of the current might reasonably be expected. But as Mr. Greenhill's dynamos are of as high efficiency as any in the market, it is probable that the saving is effected as much as anything in the transmission of the power from the engine to the dynamo, a matter about which electricians, especially in small installations, seem to trouble themselves but little, though it would repay attention quite as well as the most painstaking study of the best proportions for the electrical and magnetic portions of the dynamo, as with the high efficiency already obtained, four or five per cent. is all that could be realised in this direction! scarcely more than the difference arising from the use of good or bad lubricants. As the installation has been so successful, Mr. Egan is about extending the use of the light throughout his workshops and dwelling house with Messrs. Woodhouse and Rawson's lamps, on the completion of which extension I will send particulars of interest.

G. Percival.

Per pro ARTHUR PERCIVAL.

Cork, *January 18th*, 1886.

The Deprez Machines.

As I have not had opportunity of reading the ELECTRICAL REVIEW for a week or two, I am unable to know whether I have been forestalled in the observation I am about to make. With regard to the machines employed by M. Marcel Deprez in the extensive experiments now being carried on between Creil and Paris, I note a peculiarity of construction wholly at variance with what I conceive to be now generally accepted ideas. In each machine there are two rings or armatures influenced by multiple electro-magnets, which latter are arranged as horse-shoe magnets, *but with a pole acting upon each ring*. How, then, is the magnetic circuit completed? The brake or yoke connecting the magnet limbs is parallel to the shaft or axis of the rings; the magnetic circuits cannot, therefore, be completed through these yokes (apparently made specially heavy for this purpose), but through the side supports of the machine, by no means a direct course. I should be much obliged to any of your readers if he would point out my error, or suggest the principle aimed at, as I understand these machines to be models of constructive design, *par l'homme qui sait.*

Paget Higgs.

Re Electrical Formulæ.

TO MR. MOON,—I ask you for bread and you give me a stone. Instead of supporting by proofs or examples your former assertions as numbered in my last letter, 4, 5, 6, &c., you repeat them as bare and as false as they appeared in the first instance. As compensation you supply a fresh lot of similar matter.

The reason why I, nevertheless, address a few words to you is, that I should like in parting from you to show you that I am not, as you think, possessed of any bitter feelings on account of your just and friendly criticism.

I see now clearly that the misunderstanding, which for a moment has arisen between us, depends upon the fact that my formulæ and your criticism belong to two quite different worlds. In those regions from which you speak to me, I see from your last letter, that the velocity, being so different in the different dynamo armatures, is no more a mechanical condition, but might be used to express the electrical merit of the machines; *there*, according to you, *men of repute* rely upon weak fields in the dynamos; there a formula like

$$1 - \frac{\kappa_1 \text{ C L}}{\text{F (size of field) V}}$$

is considered an improvement upon $1 - \frac{a\,\kappa}{\text{F V}}$ to express the same thing; there the term figure of merit would not be allowed in connection with dynamos on the ground that it is used to express the reciprocal of the current actuating a galvanometer, although the prophets use it always themselves when to the delight of mortals they treat of dynamo theories; there the sensibility of an electrical instrument is a thing widely different from its efficiency; and last, but not least, through the sublime wisdom which prevails there, it was decided that the expression "F × size of field" is

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the real formula for electrical merit (*sit venia verbo!*) which Mr. Andersen has been seeking but failed to discover.

Now, on the other side, in that prosaic practical world where I work, nearly everything is different; referring to the last point in the preceding, for instance, I should not like to see a 10 horse-power dynamo come out with a 10 times higher electrical merit simply because it is 10 times as large as a 1 H.P. one, nor in an analogous case the electrical merit of a galvanic cell to be expressed by the product of its electromotive force into the size of its plates.

But if thus, my dear sir, we work in different fields governed evidently by different laws, then, why should we fight any more?

F. V. Andersen.

January 18th, 1886.

[This controversy must now cease.—EDS. ELEC. REV.]

Magnetism.

Everyone who has attempted accurate physical investigation must concur with Mr. Smith in thinking that great caution is necessary in the manipulation of the apparatus and in the deductions from the observations.

Mr. Smith himself, in his recent articles on magnetism in your journal, has, I venture to think, fallen into some errors, which I should like to point out.

On page 33 it is said that it was found necessary to let the iron ring cool whilst revolving in a horizontal plane. This ring is afterwards found not to affect the magnet when its diameters are horizontal, but does so when they are vertical. No measurements are given. The following explanation accords better with the requirements of the case, and the theory of terrestrial magnetism :—Mr. Smith's method of treatment apparently converts the ring into an annulus of a magnetic shell, *i.e.*, with a fixed polarity on the sides, which is quite to be expected, for if whilst revolving horizontally the ring were to receive a blow so as to ensure polarity being defined, the underside will be north-seeking, and the top south. For, remembering that the "total force" at London is ·47 (dyne-units), and the value of H, the horizontal intensity, ·18, the practical effect of horizontal rotation is to eliminate H, but the ring is still in a field of force whose strength is equal to the vertical component and becomes magnetic in consequence. Let Mr. Smith, now, under similar circumstances, revolve the ring about a diameter in the three cases :—

I.—When the diameter is horizontal and east and west.

II.—When the diameter is horizontal and north and south.

III.—When the diameter is in line of magnetic dip and north and south.

The results in the three cases will, I think, be—I. No fixed magnetism, that is, as free from it as iron can be got. II. Magnetic showing poles at ends of the diameter about which the revolution took place. III. More strongly magnetic than II., with poles in the same relative position. A better and more conclusive experiment would be made with a sphere of iron similarly treated.

On page 48, Mr. Smith says—"On the other hand, if the magnets be placed *too close* to the iron, it will be found that they induce magnetism into the iron," &c. Perhaps Mr. Smith can tell us at what distance a magnet ceases to affect magnetic matter, and, what may be easier, what is the cause of the striking dis-similarity in the direction of the lines of force in diagrams 3 and 7 (fig. 1). In the former they appear to spring from the extremities, in the latter from some place situated less than a fifth of the magnet's length from the end.

In the apparatus shown in diagram 11 it would be interesting to know more of the commutating arrangements; whether it was found necessary to make any provision for eliminating retardation in coils H and K, and how freedom from induction from the other parts of the system was demonstrated.

With regard to the actual lengthening of a rod when magnetised, I can assure Mr. Smith that by means of a system of multiplying levers in connection with a mirror reflecting a beam of light, a deflection of the spot amounting to two feet is easily obtainable. The hypothesis that the distribution of the lines of force of the solenoid alters after saturation of the core is surely untenable. Why should it, and why did no one find an initial contraction instead of extension of the bar?

C. G. S.

The Analogies of Generators and Motors.

The valuable paper by Mr. Mordey you published in your issue of the 8th inst., to me, was very pleasing. Both Mr. Mordey and many of your readers will, no doubt, be interested on hearing of those analogies and laws he has lately demonstrated having been practically used. Nearly two years ago, having determined to use the Elwell-Parker dynamos as generators for transmitting power to drive underground pumps, and being at that time in search of a good motor for same, the questions arose : How should the motor be constructed to give the highest efficiency (its weight in this case being of little importance), and in what way should it differ from the generator? The matter was most carefully considered, and several experiments were made at the Trafalgar Collieries, Gloucestershire (where the machines were wanted), with the Schukert, Siemens and various Gramme dynamos as motors. By permission of Messrs. Elwell-Parker, at their works, I with Mr. Thos. Parker of that firm, further experimented on their machines. As we obtained a far higher efficiency than was expected, it led to a more careful investigation of the laws relating to the allied actions; during which, we clearly proved the analogies which Mr. Mordey now mentions. Moreover, the chief features which made that machine so efficient as a dynamo (viz., a very powerful field, with a comparatively small, low resistance, and highly magnetisable armature), we considered, and also practically proved to constitute its value as a motor.

Winding the armature with a single layer, thereby being enabled to attain a most intense field, and the greatest work for the minimum length of wire, *i.e.*, lowest resistance in armature—appeared to us to be as valuable in a motor, when driving a current through the field, as it is known to be when used in a dynamo.

Accordingly, the machines for the Trafalgar Colliery Company were built by Messrs. Elwell-Parker.

The motors had field magnets of a similar shape to their dynamo, and were compound-wound, keeping a constant field—by this means the engineman on surface can tell by his ammeter what work the pumps below are doing—the armatures had cores of soft iron wire, carefully insulated with varnish (the top layers being of a smaller wire), and wound with a single layer of copper wire. These machines were easily reversed—by reversing the current through the armature —not the slightest movement of the brushes being necessary, whether the full load was on or not. They were almost sparkless at the brushes, and have been working in the collieries ever since, running night and day, Sundays included; often working 22 hours out of 24, and are still at work, never even having had the commutators repaired.

I may mention that Messrs. Elwell-Parker (with whom I am now connected) have ever since then constructed their motors on those principles.

Those used at the Inventions Exhibition, and also those now on the Blackpool tramway, are so built, but in the latter case the field magnets are constructed of strips of wrought iron (Siemens type), being there limited for space and weight. Our experience is, that these machines, where properly handled, give most satisfactory results. We did not arrive at an accurate method of determining the power absorbed by eddy

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currents in the motor armature, and should, therefore, be much interested in any data Mr. Mordey or any of your readers could furnish on this important subject.

Carl T. Blanch Brain.

Wolverhampton, *January 19th*, 1886.

The Franklin Institute Tests of Dynamos.

I beg to enclose you a copy of a letter (contained in the *Electrical World*) which I addressed to the Franklin Institute. I was informed that the committee would take no further notice of my first letter. I should be glad if you would find it space in your valuable journal.

Charles F. Heinrichs.

233, Broadway, New York,
January 8th, 1886.

AN OPEN LETTER ON THE FRANKLIN INSTITUTE TESTS.

To the President and the Board of Managers of the Franklin Institute of the State of Pennsylvania.

Gentlemen,—I have pointed out in my letter to the *Electrical World* of the 19th ultimo, of which I forward you a copy, that the efficiencies given by your committee to the Edison and Weston dynamos are most probably too high.

The seriousness of this statement is too obvious to be passed over without due consideration. The public at large, the capitalist and the inventors individually, are interested to know the true efficiency of the dynamos tested by your committee.

A certificate of efficiency, as given in the report published by your authority, will be considered correct; but should it give an undue high efficiency to dynamos owned by the largest companies, it will be detrimental to further progress, and will prevent better systems being acknowledged.

Too many fictitious reports made by would-be experts have been given to the public during the last few years by unscrupulous promoters, and have drawn millions out of the confiding public, and there are at present corporations who are working (with their subscribers' money) the most unprofitable systems under worthless or expired patents; but are supported by fictitious statements of efficiency.

All this has produced the present distrust in any, even the most promising, practically proven and tested invention relating to electrical engineering. Hence, every testimony given by a scientific authority of your eminence ought to be jealously checked and compared with results previously obtained by other authorities, and any material differences found need well be explained.

I have shown, in my letter to the *Electrical World*, the great discrepancies between the horse-power measurements made by your committee and those obtained by other authorities; particularly the values of the horse-power absorbed by the friction of the armatures are given by your committee too small to be accepted at all.

When substituting a more probable figure for the latter items and then calculating the electrical efficiency of the dynamo, it will be found to amount to more than 100 per cent. Thus the conversion of the mechanical energy into electrical would have taken place, not only without loss, but actually with a gain, which is obviously impossible.

All measurements of the electrical energy given out by the dynamos tested by your committee must be accepted as correct, since the values of current, electromotive force and the resistance agree perfectly.

But it is to be regretted that your committee have not compared their horse-power measurements with other results obtained by a former committee appointed by your Institute. The following extracts of tests from Professors Houston and Thomson's tables are contained in the Journal of the Franklin Institute of 1878:

Name of dynamo tested.	Electrical energy in H.P.	* Approximate weight of armatures in pounds.	Number of revolutions of armature.	H.P. absorbed by friction of armature and resistance of air.
Brush ...	1·6	70	1,340	·54
„ ...	1·37	55	1,400	·45
Gramme ...	1·31	30	800	·137

* Taken from other notes.

Comparing the above values of the friction of the armatures with those obtained by Professor Adams and Messrs. Alabaster, Gatehouse & Co. (given in my letter to *The Electrical World*), it will be noted that they agree with each other and are proportionate; but the values found by your last committee agree with none of the former.

I shall now show that when substituting more probable figures for the items of armature friction the electrical efficiency of the dynamos tested by your committee will be more than 100 per cent.

Table I. of your committee report contains the data of tests of an Edison dynamo No. 5; the item for friction of the armature has been omitted; thus I may take the most probable figure. Prof. Adams found the friction of a much smaller Edison armature to absorb 1·55 horse-power. Accepting this figure, and calculating the electrical efficiency of the Edison dynamo No. 5, the following result will be obtained:

$$\frac{\text{Total electrical energy}}{(\text{Total power applied}) - (\text{power absorbed by friction of armature})}$$

$$= \frac{18{\cdot}23}{18{\cdot}89 - 1{\cdot}55} = 105{\cdot}5 \text{ per cent. (! !)}$$

Approximate calculations, made upon a basis given in my letter above referred to, show that the friction of the Edison armature No. 5 absorbs ·76 horse-power; though this figure may well be 300 per cent. too small for reasons explained; still, when accepting it, the following electrical efficiency will be obtained:

$$\frac{18{\cdot}23}{18{\cdot}89 - {\cdot}76} = 100{\cdot}5 \text{ per cent. (! !)}$$

Passing over to Table III. of your committee report, it contains the data of tests of a Weston dynamo No. 7. The friction of the armature is measured, to be from ·195 to ·311 horse-power, which can be rejected at the first glance. Prof. Adams found the friction of a Weston armature of one-third the capacity to absorb 1·337 horse-power. Accepting this figure, the following electrical efficiency will be obtained:

$$\frac{28{\cdot}47}{28{\cdot}29 - 1{\cdot}337} = 102 \text{ per cent. (! !)}$$

Taking, instead of Prof. Adams's figure, only ·82 horse-power as being spent on friction of that large armature, *the electrical efficiency would still be* 100 *per cent. (! !)*

Obviously these results are impossible, but show clearly that the whole horse-power measurements made by your committee are erroneous and too small, which explains the enhanced efficiency given to the Edison and Weston dynamos.

Trusting that the whole tests will be reconsidered by you and your committee, and when you have satisfied yourself of the improbability of the results, that the enhanced efficiencies given to the Edison and Weston dynamos be taken off the record,

I am, gentlemen, faithfully yours,

CHARLES F. HEINRICHS.

New York, *January 4th*, 1886.

[We have already commented upon Mr. Heinrichs's first communication which appeared in our columns on the 1st January. We know several well-informed engineers in this country who express grave doubts as to the accuracy of the results given by the Tatham dynamometer.—EDS. ELEC. REV.]

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 427.

AMERICAN TELEPHONE PATENTS.

WE devote a large proportion of our space this week to matters relating to the telephone as affecting the patent of Alexander Graham Bell, issued from the United States Patent Office on March 7th, 1876. Our well-remembered correspondent, Major W. C. Barney, addresses us from New York, informing us of the result of the inquiry conducted before the Secretary of the Interior Department at Washington, as to the advisability of suit being instituted in the name of the United States to test the validity of Bell's patent; then we have a copy of a lengthy letter addressed by Prof. Bell to the Attorney-General of the United States, which had not been published at the time of its dispatch to us; and we also have a continuation of Prof. Houston's collection of letters from leading American scientists respecting the Reis telephone. With regard to the first-mentioned matter, we have in previous numbers been enabled to inform our readers of the current opinion in America that Secretary Lamar would decide, as he has now done, to recommend that the Government should bring a suit to test the validity of Bell's patent. Some rather peculiar circumstances preceded the inquiry by the Secretary, and these seemed to us to justify our remarks of October 30th, to which Mr. Jerome Carty alluded in the letter which we published from him last week. It is needless to again mention those circumstances, for they were fully dealt with by us at the time of their occurrence, and do not materially affect the present position of affairs.

Mr. Lamar, at the outset of the enquiry, directed his attention to two questions: Had the Government the right to institute a suit for the purpose desired? and, if it had, was there sufficient reason for its doing so? These questions were satisfactorily settled in the affirmative in his mind, and, reporting to the Attorney-General, he delivers himself in these terms: "The allegations and the evidence touching the circumstances attending the issue of the patent are of such a nature and have such a support as to render it, in my opinion, improper to ignore or dismiss them. Such a case is presented as, I think, ought to undergo thorough judicial investigation. It appears that many suits have been pending and many are now pending between the corporation claiming this patent and others that assail it. In none of these cases has there been or can there be, as I think, such thorough investigation and full adjudication as to the alleged frauds or mistakes occurring in the Patent Office in the issuance of the patent, as could be had in a proceeding instituted and carried on by the Government itself. In a case involving such questions it seems to me especially imperative upon the Government, as duty to its own officers to vindicate or condemn, and duty to the people to set on foot and follow up a complete investigation. In my opinion, the proceeding should be in the name and wholly by the Government, not on the relation or for the benefit of all or any of the petitioners, but in the interest of the Government and the people, and wholly at the expense and under the conduct and control of the Government."

We may now expect that thorough and impartial investigation of the origin of the telephone, which has so long been held desirable, but which has never yet taken place. Whether the result be to confirm or to invalidate Bell's patent, it cannot fail in one regard to be satisfactory. It will for ever set at rest the question whether Bell shall continue to receive the emoluments accruing to him as the sole and original inventor, or whether the field shall be thrown open as far as the first principles of telephony are concerned, and each separate inventor be entitled to credit for his share in improving and developing the telephone. If the partisans of Bell are so confident as they have so frequently assumed to be, they should not shrink from an investigation of the grounds upon which their claims are based; but from the nature and tone of Mr. Bell's letter to the Attorney-General of the United States, and from other signs and tokens, we gather that they are by no means pleased at the prospect before them. We have no intention of taking upon ourselves to predict the ultimate issue of the litigation; sitting as we do, in England, and in the midst of a judicial system not precisely like that of America, it is extremely difficult to get that firm grasp of the true position of affairs which a thorough knowledge of the methods and the modes of thought of our trans-Atlantic kinsmen alone can give. But this we may say, if the Bell patent be now again upheld, an end will be put once and for ever to the claims of rival pretenders. On the other hand, the consideration of what will happen in the event of Bell's patent being annulled, opens out a most interesting field for surmise and discussion. Major Barney, in another column, indicates what might possibly be the result in this country, and no doubt some of our numerous correspondents who have given attention to the question of telephone patents will have something to say upon this subject.

The Thomson-Houston System.—The Thomson-Houston International Electric Company is at present installing a number of electric light plants in important foreign cities, and its business is rapidly developing abroad. During the past 30 days, so says the *Electrical World*, orders have been received for a 45-light plant to be installed in Milan, Italy; another of 25 lights at Palermo, Italy; one of 25 lights at Leeds, England, and also one of 15 lights at Glasgow, Scotland. The plant recently installed at Hernosand, Sweden, is now in successful operation, and is giving satisfactory results. In addition to the arc lights installed at St. Johns, Newfoundland, by this company, an order was recently received for the early installation of a large incandescent plant. The officers of the company also report several other very encouraging orders for arc-light plants from far distant countries, among which is one from Bombay, India, the equipment for which will be shipped in a few days.

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ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

VI.

THE experiments with the series wound motor (article V.)* show that the current flowing through the machine is proportional to the load, and practically independent of the electromotive force. The slight rise of current at high velocities is mainly due to the resistance of the air. If the brake had been screwed down tightly, so as to prevent the armature from revolving, then the current would have risen to $\frac{E}{R + R_1}$ where R represents the resistance of the motor between the terminals, and R_1 the resistance of the generator, neglecting the resistance of the leads connecting the two. R, in this case, is ·82 ohm, and assuming R_1 to be ·25 and $E = 94$ volts, then the current flowing whilst the armature is at rest must be $\frac{94}{\cdot 82 + \cdot 25} = 87\cdot 85$ ampères.

Supposing, now, that this motor were connected to the axle of a vehicle (it may be a small tramcar) in such a manner that the speed of the motor will be 1,000 revolutions when the vehicle travels at its normal velocity. It is evident that at starting there will be, for an instant, 87·85 ampères flowing through the machine, owing to the inertia of the mass to be overcome, and it will take a few seconds before the normal speed can be attained, during which time the current will be gradually diminishing, until it reaches an amount corresponding to the load to be propelled, and if the line is level and straight, this current will remain constant.

The author has made some experiments with a tramcar propelled by means of one motor on a level line. At starting the current flowing was 100 ampères, and in the course of 30 seconds it dropped to 40 ampères, remaining constant after; it took, therefore, 30 seconds to overcome the inertia of the loaded car, whilst the current fell at the rate of two ampères per second. Had the vehicle been travelling up an incline, then we should have used more energy to keep the car in motion, but the initial current would have been the same as before, because the one depends on the electrical resistance and the other on the load, or the mechanical resistance. In order to reduce the initial current, and thereby save the motor circuit from being unduly heated, electricians resorted to the employment of artificial resistances which are, at the moment of starting, inserted between the motor terminals and the conductors leading from the generator. By this means the current can be varied at will. But such a method of reducing the current is exceedingly wasteful; for, in order to bring the initial current of the motor under discussion, down from 87·85 to, say, 40 ampères when working with 94 volts we should have to insert an idle resistance of 1·28 ohms, and this would represent a waste of $40^2 \times 1\cdot 28 = 2{,}048$ watts, whilst the statical pull is reduced at the time when most needed. Furthermore, this machine gives at 950 revolutions with 28·5 ampères 2·59 H.P., which is only just sufficient to propel the car on a level road at the rate of, say, 7 miles an hour, the total load of car, passengers and motor being taken at 4¼ tons (no accumulators); the line, we assume, is provided with conductors, and for our present purpose we neglect the resistance of such conductors. Now, if this car had to run on very moderate inclines, and on tolerably easy curves, we should have to supply a motor of at least double the power which this one is capable of exerting, for the maximum safe current that may be employed is 35·7 ampères when 2·78 H.P. can be obtained. But a more powerful motor, constructed for the same speed and the same E.M.F., would involve wire coils of greater sectional area and less resistance, in order to carry the requisite current, and this would lead us to provide more idle resistances again for starting; moreover, this motor would doubtless be too powerful for the purpose of propelling the vehicle on the level road. To reduce the power by means of wasteful resistances is neither scientific nor practical, and we have to provide other means which will give a certain amount of elasticity to the system. Unlike steam, electricity cannot be worked "expansively," but we can find some substitute. Mr. Rowan was quite right, at the Society of Arts, last week, when he said "the whole secret of mechanical tramway work would lie in having a motor powerful enough, under certain circumstances, which would run very cheaply when it had little work to do, but which would work expansively; and up to the present he ventured to say there was nothing to compete with a simple form of steam-engine, where you had only to put a little more coal on the fire to obtain the necessary power."

We cordially agree with Mr. Rowan as far as his advice as to plenty of power goes, but in regard to the concluding sentence he knows right well that the extra shovel-full of coal would be of little avail were his boiler not powerful enough to utilise the coal, and his steam-engine strong enough to withstand the extra pressure.

Several ways of providing motors of variable power have suggested themselves to electrical engineers. One is to divide the armature circuit, that is to say, to arrange the armature wire coils in such a manner that either all the coils receive the current, or only a portion of them, or the coils, by separate commutators, may be joined in series or partly in series, and partly in multiple arc. Another mode of varying the power is to divide the field magnet coils and arrange the same by means of a multiple switch, so as to give a varying magnetic field. A third method consists in having two or more distinct electro-motors for driving a vehicle, so that with a constant E.M.F., several speeds or powers may be obtained. The author uses two motors generally of equal dimensions. Such motors are made sufficiently powerful to meet the demand of the worst part of any particular road; when both are running together in parallel, then the resistance of the circuit is smallest, and, therefore, the current large, giving the maximum power. When one only of the pair is driving the car, then the current flowing is reduced by virtue of the altered resistance, and when the motors are joined in series, the resistance is still further increased, and again the power and speed is diminished; for starting the car or travelling slowly, this latter arrangement is employed. The cables from the terminals of the motors are joined to the contact blocks of a compound switch, so that the relative positions or circuits are obtained by the movement of a single lever, and thus the power is under immediate control, and the changes can be effected instantaneously. There is no idle resistance, the consumption of energy is economised, and adjusted to the demands of the road or the load upon the vehicle, and the three powers offer sufficient variation for the purposes of street traffic. Downhill, of course, the car travels by gravitation only. On the electric tramcar which has been exhibited by the Compagnie Electrique, and worked at Antwerp last year, the power and speed of the car was varied by arranging the cells in a variety of ways, but this system can only be employed on cars furnished with accumulators, whereas the multiple motor car of the author is just as suitable for tramways provided with conductors as with accumulator cars. It is not advisable to vary the number of cells; they should always be used in series; a uniform discharge and charge prolongs the life of the cells and economises power. There were no sharp curves nor inclines to contend with at Antwerp, and, therefore, no demand for a very powerful motor; this car has, however, proved a most successful rival alongside the several steam cars and Col. Beaumont's compressed air car, and it has satisfied all the conditions laid down by the jury of the Antwerp Exhibition. It stood second only on the list as regards consumption of fuel per train mile, viz., 6·16 lbs. of coal per mile run, although the portable steam engine used for actuating the charging

* See ELECTRICAL REVIEW for December 5th, 1885.

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dynamo was an inferior one and not in thoroughly good order, therefore it may be concluded that with a large and economical stationary engine, supplying power for several electric cars, the consumption of fuel would have been much below that of the most economical steam car; compared with the electric car, the compressed air car used more than six times as much coal per car mile, and three times the amount of fuel per passenger carried.

THE BELL TELEPHONE CASE.—A LETTER.

Washington, D.C.,
TO the Hon. A. H. Garland, *October 26th*, 1885.
Attorney-General of the United States.

Sir,—I live in Washington, within a few minutes walk of your office, and have resided here for several years. I think you know this.

An instrument which I have furnished to science and the arts has made my name widely known.

I have asserted, and again assert, that I am the first inventor of it. I have received honours which would not have been bestowed had not that assertion been believed; and when my rights have been invaded, the courts of the United States have affirmed the truth of my claim and the validity of my patent.

Three weeks ago I returned from a long journey and found every newspaper proclaiming to the world, on the authority of your Department, that my assertion that I am that first inventor is false, and has always been known by me to be false; and that the patent which the United States granted to me for the invention was obtained by false and fraudulent suggestion and concealment on my part. I find myself charged by your Department with perjury and fraud.

This charge, the newspapers inform me, was made in a suit brought, not in Washington, where you know I reside, nor in Massachusetts, where the company which is the sole owner of my patent has its domicile, but in Tennessee, where I never have been, and where the owner of my patent has not even an office or an officer.

The suit was brought at the instigation of convicted infringers of my patent; the counsel appointed to prosecute it are their counsel; and its pendency was announced by a United States District Attorney at Baltimore, as a reason why a United States court there should not hear, against one of those infringers, a motion for injunction which it had previously ordered to be heard.

The infringer, which so attempts to use this action of your Department, to shield itself from judgment, is a corporation of which you were one of the organisers, one of the largest stockholders, director, and counsel.

I seek for some explanation. I find that the explanation you gave was so far from sufficient, that upon it alone the suit was instantly dropped. But the very letter of the Solicitor-General, which announced that the suit was withdrawn because the charges were made without proper examination, re-asserted them.

I deny every one of these charges. The official records absolutely disprove them. I propose to call your attention to those records.

The bill, authorised by your Department, alleges (p. 21) that "Prof. Phillip Reis, a German scientist," "was in fact the true and original inventor and discoverer of the electric transmission of sound, speech, and conversation, and the method thereof;" that (p. 17) "at least as early as 1862," by "instruments, apparatus, and methods," invented by said Reis, he "*practised the art of electric transmission, both of articulate speech and musical tones;*" that this art "had long prior to said Bell's pretended invention been openly and publicly practised, not only by the said Reis, but by others," by the "method, means, and instruments so invented and described by said Reis, or by the use of apparatus . . . . described or sold to them by said Reis," and that this was accomplished by the "same form of currents, and in the same manner and use of application of electricity," shown in my patent.

Your District-Attorney's bill alleges (p. 18) that said art

> "had been since the year 1862 not only publicly known and practised by others than him, said Bell, but the apparatus necessary therefor, and the method or principle, as well as practical direction for the electric transmission of both tones, musical notes, and speech, had been published and described in such minute details in a very large number of printed publications published both in the United States and in foreign countries, that from said publications any person reasonably skilled in the art of applied electricity could of himself construct the instruments, apparatus, or devices necessary for the electric transmission of sound and speech, and so apply electric currents thereto and therewith, as to operate said prior invention and art, and transmit electrically both tones and articulate speech."

It enumerates seventy-five publications and patents, each of which, so it alleges, contains this information.

The bill adds (p. 16) that everything shown or claimed in my patent was "in truth and in fact old and well-known to all scientists and physicists conversant with science so far as it relates to electricity."

The bill says (p. 15) that all this was so well-known as the state of the art that I "cannot be heard to say" that I was ignorant of it.

Whereupon your District-Attorney charges me with perjury and fraud, because I swore that what he calls so well-known an invention was my own, and because, so he avers, I

> "Deliberately, deceitfully, and knowingly contrived, and until after said letters patent were actually allowed and delivered to him, did actually conceal from the said examiner, and from the officers of the United States in the said Patent Office, charged with the examination of his said pretended discovery and invention, all knowledge and information of the true state of the art in that behalf and respect."

I am charged with "concealing from the Patent Office" the existence of an art alleged to have been at that time well known to the whole civilised world, and long openly and publicly practised.

You, sir, would not have made that assertion, because you personally know that before my patent no such art existed.

Only last year your associates in the Pan-Electric enterprise, in the name of the *Washington Telephone Company*, by a printed circular, headed with the names of General Bradley T. Johnson and Mr. Casey Young, publicly asserted the following:

> "The surprising rapidity with which the telephone has been adopted as a means of communicating intelligence between distant points surpasses all the wonders of this wonderful age. *It was first exhibited to the public at the Centennial Exposition in 1876, and the first line for practical use was constructed in Boston in 1877.* To-day, after a lapse of but seven years, there are more than 250,000 instruments in use, and the number is increasing at the rate of over 50,000 a year."

That "first" exhibition was *my* exhibition; that "first" line was *my* line. Every one of those instruments was made under my patent, stamped with its date, and furnished by its owners.

Such was the origin of the art.

When I filed my application I asserted that I was the first inventor of that art. I believed so then; I know so now.

In 1876 the United States appointed, to examine the electrical inventions at the Centennial Exposition, an international board of judges, who certainly were "scientists and physicists conversant with science in so far as the same relates to electricity." At their head was Joseph Henry. I exhibited my telephone to them on the 25th of June, 1876, and they heard speech electrically produced. They took my apparatus to their consultation room, and used it by themselves. In their official report, drawn by Prof. Henry, after referring to the transmission of musical notes by current interrupters, they said (Dowd case, vol. ii., p. 32):

> "The telephone of Mr. Bell aims at a still more remarkable result—that of transmitting audible speech through long telegraphic lines." . . . "To understand this wonderful result," &c., &c., "This telephone was exhibited in operation at the Cen-

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tennial Exhibition, and was considered by the judges the greatest marvel hitherto achieved by the electric telegraph. The invention is yet in its infancy, and is susceptible of great improvements."

The most important of the Reis publications were in the Smithsonian library. Prof. Henry had for two years had a Reis apparatus in his cabinets there. Yet to him and his associates a speaking telephone of feeble sort, constituted in June, 1876, "*the greatest marvel hitherto achieved by the electric telegraph.*"

Yet your District-Attorney asserts that speaking telephones had long been so well known that I could not be heard to say that I was ignorant of them.

For not telling to the Patent Office what Prof. Henry and his associate judges at the Centennial did not know, I am accused by your Department of "cunning concealment" and wilful perjury.

The Patent Office and the courts, in many contested cases, after fully considering every Reis publication mentioned in your District-Attorney's bill, have decided that the art of transmitting speech by electricity *was not there to be found*, and did not exist before the date of my invention. (Telephone Interferences, 30 O. G., 1091; Am. Bell Tel. Co. *v.* Spencer, 8 Fed. Rep., 509; Same *v.* Dolbear, 15 Fed. Rep., 448; Same *v.* People's Tel. Co., 22 Fed. Rep., 109; Same *v.* Molecular Tel. Co., Fed. Rep., —).

Yet I am charged with fraud and deceit for not telling the Patent Office, in 1876, that which the Patent Office itself and all the courts, after careful and elaborate investigation, have since decided to be untrue.

How could the United States make that charge against me? How can the Washington Telephone Co. —the author of that circular—now ask you to repeat that charge?

In each and every case, the Patent Office and the courts have decided that I am the first inventor of the electric speaking telephone.

After seven days of hearing, the Commissioner of Patents decided:—

"He (Bell) invented the art or method, and also an apparatus, by which said art or method could be practised. His claim as an inventor is for having done that thing in its entirety." . . . At the Centennial Exhibition "the world recognised Bell as the first inventor of a speaking telephone. The indications are that it was not until the promised reward for so important a public service became visible that his claim to priority was called in question by any of the parties to this interference." (30 Official Gazette, 1091.)

Your District-Attorney's bill charges another fraud, namely, that I, not being the inventor of the speaking telephone, unlawfully saw a caveat of Mr. Elisha Gray which described one, and afterwards by an amendment to my application then pending, wrote this into my specification, and obtained the patent for what I had not invented, but had so stolen.

Your District-Attorney alleges (p. 8) that the Examiner in the Patent Office, on February 19th, 1876, "wrongfully gave to the said Bell information of the matter contained and set forth in the said caveat of Gray," and (p. 9) that the said Bell, "being well aware of the nature of the invention of the said Gray, as disclosed in said caveat, through and by reason of the betrayal of confidence by the said Examiner," thereupon, for the purpose of stealing that which, so the bill avers, Gray had invented and Bell had not, did, on February 29th, make a certain amendment to his specification, and (p. 10) that the Examiner allowed this, "well knowing that the said amendment was suggested by the unlawful disclosures made by him touching the matters contained and set forth in the said caveat of the said Gray."

I specifically deny that I was indebted to Mr. Gray for any part of the invention described in my patent.

The original files of the Patent Office show that the description of the speaking telephone stands in my patent to-day *exactly as it stood in my application written and filed before Mr. Gray's caveat existed.*

The records in the Patent Office show the following facts:—

1. On January 20th, 1876, I swore to my application in Boston, where I then resided.

2. On the morning of February 14th, Messrs. Pollok and Bailey, my solicitors in Washington, filed it in the Patent Office.

3. On the afternoon of that day Mr. Gray swore to and filed a caveat, suggesting the idea of a telephone, and swearing that he was "engaged in making experiments for the purpose of perfecting the same, preparatory to applying for letters patent therefor."

4. On February 19th the Office gave the notices customary in cases where there is a prior caveat on file —one to Mr. Gray, care of his solicitor in Washington, informing him that an application had been filed which apparently interfered with his caveat, and one to Messrs. Pollok & Bailey, informing us that "the 1st, 4th, and 5th clauses of claim relate to matters described in a pending caveat," and that my application was therefore "suspended for 90 days, as required by law."

All this was according to law and the established practice of the Office.

I am advised that R. S. 4903 and the rules of the Patent Office required the notice to inform me what claims were interfered with, in order that I might drop them if I saw fit, and the affidavit of the examiner, Wilbur, filed with you by my opponents, states that such was the practice of the Office.

I am advised that according to R. S. 4902 a caveat is operative "from the filing thereof." Upon a written petition filed by my solicitors the Commissioner ascertained that the caveat was filed some hours later than my application, and, by a written opinion and order, decided that the notice of interference should be withdrawn. This was done February 25th, 1876, and the patent issued March 7th, 1876.

But the notice of interference *had* been sent to Mr. Gray on February 19th. He has since testified that he received it. (Dowd Case, vol. 1, p. 136.) It is a fact that he had ample opportunity to file an application after the withdrawal of the notice, and thereby contest my claims, had he been so minded; but he and his counsel deliberately determined not to do so.

I was not in Washington, and had no personal knowledge of these proceedings until after the notice had been withdrawn; but I am advised and believe that all of them were exactly according to law. Whether they were so or were not, it was not a fraud on my part nor on the part of my solicitors for them to receive and read the official communication sent to them by the Commissioner, nor for them to ask his personal and careful examination into the exact truth of the matter, and to abide by his formal judgment placed on the public records of the Office.

The gravamen of the charge in the bill lies in the suggestion that in consequence of unlawful information (alleged, but untruthfully, to have been given by the Examiner to me) *I changed my application so as to include the invention of Gray, and thus stole from him the speaking telephone.*

The original official records of the Patent Office absolutely disprove the possibility of the act alleged.

1. No such change was made. All the part of my specification which describes or claims the speaking telephone stands in my patent exactly as it was written in the original application now in the files of the Office, and placed there on the morning of February 14th, 1876, *before Mr. Gray's caveat existed.*

2. That description and claim as filed, had been explicitly stated by the Office to set forth the invention described in Mr. Gray's caveat. It was on that ground that the interference was declared, and it could not have been declared on any other.

The only change ever made in my specification was the following:

On February 29th, upon an oral suggestion of the Examiner, which he made to me personally, and in order to give greater precision to the language, I added an explanation of the difference which existed between the electrical changes described in an *application of my own of a year earlier*, and those *already* described in my specification in question. This amendment was drafted by me personally. Of course, I did not reswear to the words, as they added nothing, and the Office did not ask me to do so.

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The only amendment ever made consisted in inserting in the specification the words following that are printed in Roman letters; the part in italics was in my application as originally filed :

"In a pending application for letters patent, filed in the U.S. Patent Office, February 25th, 1875, I have described two ways of producing the intermittent current, the one by a dual make and break of contact, the other by alternately increasing and diminishing the intensity of the current, without actually breaking the circuit; the current produced by the latter method I shall term, for distinction's sake, a pulsatory current.

"*My present invention consists in the employment of a vibratory* or undulatory *current of electricity, in contradistinction to a merely intermittent* or pulsatory *current, and of a method of and apparatus for producing electrical undulations upon the line wire.*

"The distinction between an undulatory and a pulsatory current will be understood by considering that electrical pulsations are caused by sudden or instantaneous changes of intensity, and that electrical undulations result from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations. The electrical movement, like the aerial motion, can be represented by a sinusoidal curve, or by the resultant of several sinusoidal curves.

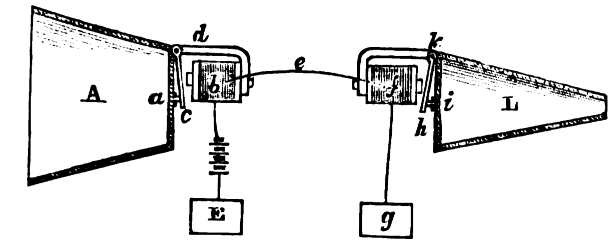
"Intermittent or pulsatory and undulatory currents may be of two kinds, accordingly as the successive impulses have all the same polarity, or are alternately positive and negative."

"Page 13, line 15, after '*synonymously*,' insert 'and in contradistinction to the terms 'intermittent' and 'pulsatory.'"

"In the 4th claim erase the word '*alternately*,' whenever it occurs, and substitute therefor the word 'gradually.'"

But the speaking telephone stands described and claimed in my patent in the exact words of my original application, no one of which has ever been changed. After describing the apparatus fig. 5, which is a multiple telegraph, and nothing else, it describes the instrument fig. 7, which is a speaking telephone, and nothing else, as follows :

"The armature *c*, fig. 7, is fastened loosely by one extremity to the uncovered leg, *d*, of the electro-magnet, *b*, and its other extremity is attached to the centre of a stretched membrane, *a*. A cone, A, is used to converge sound vibrations upon the membrane. When a sound is uttered in the cone the membrane, *a*, is set in



vibration, the armature, *c*, is forced to partake of the motion, and thus electrical undulations are created upon the circuit, E, *b*, *e*, *f*, *g*. These undulations are similar in form to the air vibrations caused by the sound—that is, they are represented graphically by similar curves.

"The undulatory current passing through the electro-magnet, *f*, influences its armature, *h*, to copy the motion of the armature *c*. A similar sound to that uttered into A is then heard to proceed from L."

. . . .

Claim 5. "The method of, and apparatus for, transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

The variable resistance transmitter is also described in my patent in the same words as in my original application, as follows :—

"Electrical undulations may also be caused by alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery." . . . "The external resistance may also be varied. For instance, let mercury or some other liquid form part of a voltaic circuit, then the more deeply the conducting wire is immersed in the mercury or other liquid the less resistance does the liquid offer to the passage of the current. Hence, the vibration of the conducting wire in mercury or other liquid included in the circuit occasions undulations in the current."

When my patent was issued and the speaking telephone introduced to the world, Mr. Gray was one of the first to know of it and to recognise my title. In the Dowd suit he testified that he received the premature notice, that he inferred that I was the applicant referred to (we had previously been, and then were, in conflict about other electrical inventions), and *knew* this when, shortly afterwards, he received a copy of my patent from his counsel. (Dowd case, vol. 1, p. 136.) I exhibited my speaking telephone to the judges at the Centennial Exhibition, on June 25th, 1876; Mr. Gray was present, personally listened at the instrument, repeated to the audience what he heard, and says that it was the first time he had ever listened at a speaking telephone. (Dowd case, vol. 1, p. 138.) About the same time he received (so he testifies) my lecture of May 10th, 1876, in which I again described various forms of it, including some liquid transmitters. (Dowd case, vol. 1, p. 125.)

Mr. Gray received a copy of my second patent (186,787) January 30th, 1877, as soon as it was issued. He wrote me on February 21st, 1877, that he was about to give a lecture on his musical telegraph; that he had a copy of my last patent, and asked my permission to construct and exhibit *my* apparatus, adding (Dowd case, vol. 1, p. 146) :—

"I should explain it as *your* method, and not mine, although the Office records show a description of the talking telegraph filed by me the same day yours was filed. *The description is substantially the same as yours.* I was unfortunate in being an hour or two behind you. There is no evidence that either knew that the other was working in this direction."

Mr. Gray, therefore, then recognised that the "*talking telegraph*" was as well described in my specification written in January as in his caveat written in February, and filed "an hour or two" after my application, and that all that was in my two patents was justly mine and not his.

March 5th, 1877, he wrote me again (*ib.*, 148) :—

"I gave you full credit for the talking feature of the telephone, as you may have seen in the associated press dispatch that was sent to all the papers in the country, in my lecture in McCormick Hall, February 27th, 1877. . . . . I described your apparatus at length by diagram."

Mr. Gray exhibited his musical telegraph (which at that time he termed a "telephone") at a public meeting in New York, in April, 1877. The *New York Tribune* of April 3rd, 1877, contained the following (Dowd case, vol. 1, p. 156) :—

"After the first part of the programme had been executed, Mr. Elisha Gray came forward and addressed the audience. He was aware that great confusion existed in the popular mind as to what this telephone could perform; in particular, it had been confounded with the speaking telephone invented by Prof. A. Graham Bell, of Boston. Prof. Bell, Mr. Gray said, was present in the audience."

I was present; I heard Mr. Gray make that statement; and in the Dowd case it was admitted that he did make it.

My second patent of January, 1877, was for improvements in magneto instruments. Mr. Gray testified in the Dowd case (vol. 1, p. 127), that he believed the magneto transmitter to be entirely new with me.

All the facts relating to this matter have been more than once judicially investigated by the courts and by the Patent Office, and the decision has invariably been in my favour. In 1877, when the Western Union Telegraph Company was sued for infringing my patent, it bought Gray's claims, filed an application for a patent on his caveat, and an interference was declared between that application and others of his applications and my two patents. After long hearings, the Office decided that he had no right to claim the speaking telephone, and that I was the first inventor of it. It also decided particularly that the liquid transmitter and the receiver of Mr. Gray's caveat were described *in my previously-drawn application, and that I was the first inventor of them.* (15 O. G., 776; 30 O. G., 1091.)

Your District-Attorney's bill alleges that my patent neither describes nor claims a speaking telephone.

I need not discuss that question. My patent is now before the Supreme Court in Dolbear's case (No. 368 on the docket), and in the Molecular case; and with it are all the Reis publications named in the bill. You need not bring a new suit in Memphis to try that; but the question has been often decided. Indeed, your bill so shows.

The said letters patent were granted and issued to me on the 7th day of March, 1876, and were numbered

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174,465. Now, the bill of complaint itself confesses that on the 19th day of the preceding month my application had been declared to interfere with the caveat of Mr. Elisha Gray, referred to above. The records of the Patent Office show that this caveat advanced but one single claim, namely, a claim to the invention of "the art of transmitting *vocal sounds or conversations telegraphically* through an electric circuit."

It thus appears from the records and from the bill of complaint itself that the Patent Office knew on and before the date of my patent that my claims included, and were intended to include, a speaking telephone, and ordered an interference on that ground alone.

Mr. Gray also wrote that he found it in my patent (p. 12, *supra*).

In the first contest which arose the Commissioner of Patents so decided. Referring to the passages in my specification, which have been quoted above, he said (15 O. G. 776):

"Nor is the fifth claim of Bell's patent (No. 174,465) limited to the transmission of other sounds than articulate speech; for, if the word 'vocal' in the claim itself could leave the question in doubt, the description in the application would remove such doubt."

The meaning and scope of my patent has been exhaustively determined in that opinion and in the decision of Mr. Justice Gray in Dolbear's case (15 Fed. R., 509).

My patent is nine years and a half old. I have referred to the honours I have received, and to the decisions by which my title has been sustained. These judicial investigations have been aided by more than thirty printed volumes of evidence and arguments; more than fifty days of oral argument; while more than thirty counsel and twenty-five experts have given the aid of their skill to my opponents. Every contest has resulted in a decision in my favour.

How came the United States to prefer against me charges which have so often been refuted by its courts, and which its own official records in its Patent Office absolutely disprove?

When my patent was seven years old, and after it had been sustained by the courts, and when 250,000 of my instruments were in use, a group of Senators and Representatives in Congress formed the "Pan-Electric Telephone Company," which proposed to "monetise" a paper capital of five million dollars by using telephones like those which had been adjudged to infringe my patent. (See their contracts recorded in the Patent Office, May 21st, 1884, and September 17th, 1884).

The Philadelphia branch which this company had agreed to defend was perpetually enjoined June 26th, 1885. At the time the application was made to you, a suit for infringing my patent had been brought at Baltimore against the *Pan-Electric Company*, its branch the *Washington Telephone Company*, Gen. Bradley T. Johnson, as president of the latter, and Mr. Casey Young as director of both. In that suit a motion for an injunction was ordered to be heard on September 15th, 1885.

About 1883—4 the *National Improved Telephone Company* was formed by parties interested in the Pan-Electric Company for similar purposes with a similar capital. Its Pittsburg branch, defended by it, was enjoined *pendente lite* July 8th, 1885. That suit is to-day ready for final hearing.

The grounds of attack presented by your District-Attorney's bill could be heard in those suits—and speedily, if a trial of them was what was wanted. But the infringers preferred, if they could, to escape or postpone a hearing.

Your letter to the President states how they went about it:

"Some day last summer, I do not recollect the precise day, some gentlemen approached me stating that they desired to *make application in the name of this company, of which I was a stockholder and attorney,* FOR THE USE OF THE NAME OF THE UNITED STATES to test the validity of the Bell telephone patents in the courts. Those gentlemen were Mr. Casey Young, Col. George W. Gantt, Mr. Van Benthuysen, and one other gentleman whose name I do not recollect."

Mr. Casey Young was director, secretary and counsel of the *Pan-Electric* and director of the *Washington Telephone Company*, and personally a defendant in the Baltimore suit; Mr. Gantt had already appeared as counsel for the *Pan-Electric* in a suit between it and the owners of my patent.

You took no official action, but left them with the understanding that the application should be renewed, for in your letter to the President you say:

"After the interview with the gentlemen already spoken of, I supposed they would come to me with an application after the statement I had made, to either refer the matter to the Solicitor-General or to present it to you as the head of the executive department of the Government for your consideration."

So they came again to your Department to borrow from it the name of the United States.

On August 27th you left Washington for a vacation.

Saturday, August 29th, is the date of an application to the District-Attorney at Memphis (the domicile of the Pan-Electric Company) asking him to bring a suit there, praying that my patent be cancelled. On Monday, August 31st, his mind was made up, and he sent a letter to your Department asking permission.

This letter reached your Department on September 2nd, and was received by the Acting Attorney-General (the Hon. John Goode). At the same time the Acting Attorney-General was waited upon by Senator Isham G. Harris and Congressman Casey Young, vice-president and secretary and counsel for your company, "The Pan-Electric."

On the next morning they called again, and were informed that the Acting Attorney-General had already sent the permission asked for—so swift was justice! He had also ordered that special counsel assist in my prosecution, and had named for that purpose Messrs. Young, Gantt, and Wright, counsel for the Pan-Electric Company, and Mr. Beckwith, counsel for the National Improved Telephone Company—on condition that the United States be at no expense for their fees—so sure was he that the United States had no interest which would justify an appropriation.

In the ordinary course of mail this order would reach Memphis on September 5th. On September 9th the bill and schedules of forty printed pages were filed in print, and the imprint on them is that of a New Orleans printer.

Do not these dates and this unwonted swiftness show that the private prosecutors had prepared the papers beforehand, and looked upon the application to your Department as a mere form, the outcome of which they felt sure of; and that no real examination could have been made or was expected?

But why this haste?

On the same day that the bill was filed a special dispatch from Memphis was sent to the Chicago *Inter-Ocean*, and published on September 10th, which said:

"The attorneys here claim that the effect of filing the Bill will be to suspend proceedings of the Western Union and Bell Telephone people against other telephone companies."

Whereupon those who procured the bill to be filed proceeded to use it in a suit in which the Pan-Electric Company and its associates, and one of those very attorneys, were defendants. On September 15th, when the motion of the Bell Company for an injunction against the Pan-Electric Company and the Washington Telephone Company came on to be heard at Baltimore, Mr. Sterling (who is the United States District-Attorney) said to the Court:

"Now it does strike me that so far as a preliminary injunction is concerned, it is a valid objection to a preliminary injunction if, since these other decisions, the United States has filed a bill alleging the patent to be void, alleging it to have been fraudulently obtained, and asking the Court to declare it void. . . . It does seem to me to attack the validity of this patent in a form and in a mode of action which is an absolute bar to the proper exercise of legal discretion in granting a preliminary injunction."

To enable the promoters to say that the action was made in your absence, and at the same time have it in season to use at Baltimore, there was no time even for the usual reference to the Interior Department—and none was made.

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I am informed that only four such suits had been brought in the history of this country, and, in one of them *United States* v. *Fraser* (22 Fed. R., 106), a suit to cancel a patent for invention, the Court said :

"It is now only at the instance of parties who are specially and directly interested in their defeat, and who, by the showing of the bill, have a complete defence against both these patents, that the name of the Government is lent to these contestants to attack these patents, and that only upon the guarantee that the Government is to incur no costs. . . . Would it not be better to leave the attack upon such patents as have been obtained by false suggestions where they have heretofore been left, as defences to the validity of the patents."

The Court there decided that a court of equity would not entertain a Bill brought under such circumstances, and dismissed the suit.

United States v. *Throckmorton* (98 U. S., 71), was a suit to cancel a land patent. The Supreme Court said :

"It would be a very dangerous doctrine and one threatening the title to millions of acres of land held by patent from the Government, if any man who had a grudge or claim against his neighbour can, by indemnifying the Government for costs and furnishing the needed stimulus to the District Attorney, institute a suit in chancery in the name of the United States to declare the patent void."

Whereupon, the Court decided that it would not entertain such a suit, and dismissed it on demurrer.

I am not blind to the real character of the proceeding sanctioned by your Department. It was not your personal act. It did not even originate with your Department. It was due to convicted infringers. There is reason to fear that they hoped the influence of your known personal interest would make action more speedy and scrutiny less careful. Plainly a proper examination would have defeated their scheme.

I know that the official order was given by the Acting Attorney-General (Solicitor-General) while you were absent from Washington. But the facts remain that you knew of the first application and expected its renewal; that the action was unusual, taken with extraordinary haste, without time for suitable examination, without the usual reference, in the face of repeated decisions of the courts, in spite of absolute disproof from the records ; that it selected a forum unlawful and oppressive ; that it was in substance at the instance (in part at least) of a corporation in which the head of the Department had an enormous interest, urged by the personal presence of your co-directors, and instantly (though unavailingly) employed in the attempt to protect that corporation from a trial where each allegation, *if true*, would be a defence for it.

I have no fear that my recognised position as the inventor of the speaking telephone will be impaired in the estimation of scientific men and the world at large by the attack that has thus been made upon me ; but I have not the philosophy to endure with patience the accusation of fraud and perjury brought against me in the name of the Department of Justice of the United States, even though the Patent Office, which granted my patent, and the courts which have sustained it, are included in the accusation.

I have, therefore, made this statement of facts to be filed in the records of your office.

I am, sir, yours respectfully,

ALEXANDER GRAHAM BELL.

THE NEW PERSIAN GULF TELEGRAPH CABLE.

We were enabled some weeks ago to announce the successful completion of the cable from Bushire to Cape Jask, in the Persian Gulf. The following report by Sir J. U. Bateman-Champain, R.E., K.C.M.G., giving details of the operation, will be found interesting :—

Indo-European Government Telegraph Department,
Karachi, *December 1st*, 1885.

Sir,—On the 29th of April I received instructions from the Right Honourable the Secretary of State to take the necessary steps for obtaining tenders for the manufacture of a new cable be laid between Jask and Bushire, and also to arrange in due time for its shipment and submersion.

On the 18th of June the manufacture was commenced at Silvertown. The work went on smoothly and satisfactorily under the electrical supervision of Messrs. Clark, Forde & Taylor, who undertook to maintain careful and constant testing at the factory.

After arranging for the making of the cable, the next most important consideration was the engagement of ships in which to convey it to the Gulf and there safely deposit it at the bottom of the sea.

We calculated that the expedition would last 100 days from the time the ships left Silvertown till their return to that place. We required more than 3,000 tons gross tonnage, and it was essential that the ships should be fitted with cable tanks, paying out machinery, testing rooms and appliances, a steam launch, and other apparatus. Our own cable hands and Lascars at Karachi would not be sufficiently numerous for the work, and therefore it was made a condition in the charterparty that the vessels should carry and place at our disposal a certain number of experienced cable hands, to whom, as well as others of the ships' companies directly employed in the operations, a gratuity of half a month's pay should be granted by Government on the successful completion of the work.

Eventually the two cable ships, *Dacia* and *International*, the property of the India Rubber and Gutta Percha Telegraph Works Company, were engaged for a lump sum of £17,500. Twenty-one days after the arrival in India were to be given for the completion of the work, after which demurrage, at the rates of £100 per diem for the *Dacia* and £75 for the *International*, was to be paid by the Government.

For the important duties of testing the cables on the outward voyage I sent for Mr. Harrison (an acting assistant superintendent in my department) from Karachi, and placed him in charge on board the *International*. Mr. F. Maclean, a superintendent of the Indian Department, returning from furlough, volunteered to test the cable on the *Dacia*.

As regards the loading of the vessels, the best way in which to distribute the cable in the different tanks, and the condition of the cable machinery, &c., we took the professional opinion of Mr. F. C. Webb, an electrical engineer of great experience, who was in former years employed by the Government of India on the Persian Gulf cables, and his reports were of great use.

The cable was all on board by September 20th; Messrs. Clark, Forde & Taylor's certificate was thoroughly satisfactory; and on September 19th I decided that the *Dacia*, with Sir Henry Mance, myself, and others on board, carrying 339 miles (1,260 tons) cable, 350 tons coal, and 140 tons stores, should sail from Greenhithe for Karachi on October 6th. The *International*, with Mr. Harrison in charge, and 191 miles (735 tons) cable, 260 tons coal, and 90 tons stores on board, was to sail three days later, direct for Jask.

Complete information as to our plans and instructions as to local preparatory action had been previously supplied to Mr. Ffinch, and through him to Captain Bishop, commanding the departmental cable vessel, the *Patrick Stewart*. The last-named ship was to join us either at Karachi or Jask.

We reached Karachi on the morning of November 10th, and, after taking on board Mr. Ffinch, several clerks, foremen, and cable hands, European and native, and a considerable amount of cable stores and paraphernalia, we sailed again on the evening of the 11th for Jask. We began rather badly, the *Dacia's* steam-launch "carrying away" while being hoisted, and flinging a man overboard. Life-buoys were thrown to him and he was promptly picked up, but we were compelled to leave the sunk launch, buoying the spot so that she could be recovered hereafter.

On the morning of November 14th we anchored off Jask, and were pleased to find the *International* awaiting us, she having arrived direct from Aden the previous evening. The *Patrick Stewart* steamed in from the Gulf four or five hours after ourselves. Mr. Harrison reported that the cable under his charge was, like our own, in perfect order.

Next morning, the 15th, the actual work of laying the third Persian Gulf cable began. At this moment all communication with Europe by our line was suspended, owing to a break in the 1869 India-rubber cable close to Jask. The *Patrick Stewart* promptly repaired this, and at the same time the *International* began landing our new Jask shore end. By means of balloon buoys, and thanks to the magnificently calm weather, the heavy end from ship to shore, half a mile or so long, was safely laid in the incredibly short space of 13 minutes. At 12.30 we commenced paying out from the *International* towards Bushire at a speed of about four knots an hour. The *Patrick Stewart* led the way, and the *Dacia* followed us, taking frequent soundings for our information and guidance hereafter. The repair of the India-rubber cable was very lucky, as we were now in direct telegraph communication, not only with Jask but also with our goal, Bushire, and were thus kept acquainted with the state of the weather ahead.

On the morning of the 17th we had laid the 191 miles of cable from the *International* and buoyed the end. We transferred ourselves, our staff and stores, to the *Dacia*, and bade good-bye to the other vessel, which, by 10.30 a.m., had finished all she had to do for us and was under way for Karachi.

After splicing on to the buoyed end of the cable we started afresh for Bushire. On the 18th the sea was somewhat rough, but so smoothly and well did the cable machinery work that no anxiety whatever was experienced, and we were able to pay out at a rate of over six knots per hour. That night it seems the *Patrick Stewart* hardly made sufficient allowance for current, and led us a few miles further south than the course intended. This was some-

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what unfortunate, as the soundings showed that we passed over a shoal which we meant to avoid. On this patch we laid the cable in 15 fathoms depth instead of 40, and there is some cause for fearing that the irregularity of the bottom may, in the course of years, tell on the cable and cause a break. It may be desirable to lift and relay this short length, at some future date, a work which the *Patrick Stewart* can perform with ease at any time.

Early on the 20th we had laid the whole line to within six miles of Reshire, the site of the Bushire telegraph offices. The main cable was cut and buoyed, and by 9 p.m. the shore end was laid and joined up in the cable office, and the work was satisfactorily finished. I believe no smarter piece of cable laying has ever been done. Thanks to Sir Henry Mance's admirable foresight and powers of organisation, and thanks to the energy and devotion of our departmental officers and men engaged, more than 500 miles of cable (sanctioned only in the latter end of spring) have been laid in perfect order, and at an extraordinarily small cost, punctually by the date foretold. We are thankful to have been favoured by the weather, and with the exception of the little accidents noted above (which did not interfere with the work), no difficulty, no unpleasantness, in short, no hitch occurred from first to last.

We arrived at Karachi on November 29th, and relinquished control of the *Dacia* on the 1st of December, having employed the ship for a little less than the 21 days allotted for our task.

I now beg to be allowed to repeat that to Sir Henry Mance is due the credit of what I trust will be admitted has been a thoroughly successful expedition, but I must say that the other gentlemen engaged performed their very important functions with the greatest zeal and assiduity. The staff was divided into two watches, neither being day or night more than four hours at a time off duty. The records and observations kept during the laying will be fully described in the engineer's report, which, I think, ought to be printed when we return to London. Messrs. Possman and Sealy had charge of the watches, and were untiring in their exertions. They were most ably assisted by Messrs. Harrison, Allen, Andrews and Hopkins, of this department, while records of the soundings, of the position of the paying-out ships, and the amount of cable expended at any particular minute, with a variety of other useful details, were, under Messrs. Possman and Sealy's superintendence, kept with admirable precision and care by Mr. Twisaday, of my London office, and Mr. Bailey, an *employé* of the India Rubber and Gutta Percha Company. Four or five junior clerks were told off for day and night signalling by steam whistle, flags, or hand lamps to the *Patrick Stewart*. Mr. Brown and the foremen and cable hands under his immediate charge likewise carried on their share of the work as well as possible. I must also express my warmest thanks to Mr. Ffinch, the director of the Persian Gulf division, for the accuracy and completeness with which everything at Karachi and at the Gulf stations had been prepared for us beforehand. Mr. Ffinch accompanied the expedition, and co-operated with Sir Henry Mance and myself in the most cordial and energetic spirit.

Lastly, I desire to record my warm appreciation of the conduct of the officers and men in the employ of the India Rubber and Gutta Percha Company on both the ships *Dacia* and *International*. Captain Tindall, of the latter vessel, and Captain Wilson Barker, of the former, helped us in every possible way, and nothing was omitted which could assist in making the voyage out agreeable and the cable laying successful. Both ships were, as is the custom with the company, under the absolute orders and control of Mr. Theophilus Smith, an electrical engineer of experience and ability, to whom, for his great kindness and constant attention, we all feel sincerely grateful. I can truly state that from the day we embarked at Greenhithe till we finally left the *Dacia* this day, there has been, thanks in a great measure to Mr. Smith's tact and consideration, no dispute or difference of opinion of any sort between the officers of the Government and those of the India Rubber and Gutta Percha Company.

I have the honour to be, Sir, your most obedient servant,

J. U. BATEMAN-CHAMPAIN,
Colonel, R.E., Director in Chief.

The Under-Secretary of State for India.

THE REIS TELEPHONE.

(*Continued from page* 77.)

PROF. A. E. DOLBEAR—

Dear Sir,—I tried in connection with Prof. Van Dyck the Reis transmitter (an exact duplicate of the instrument made by Prof. Reis as I am informed and believe) with an ordinary receiver, and was surprised at the ease and distinctness with which I could hear the sentences transmitted. They seemed at times as clear as though sent by the modern telephone, but the instrument required occasional adjustment. It seems to me there is no doubt that Reis invented a speaking telephone that worked on the same principle as the modern one, and not by a make and break circuit, though I am not certain what his theory about it was. I think his telephone would have successfully worked in the transmission of speech if his receiver had been sufficiently sensitive. The fault was chiefly in the receiver and not in the transmitter. The telephone of to-day is an improvement on his, but retaining the same principle on which his works—variation of current from variation of pressure. Very respectfully,

(Signed) GEORGE. B. MERRIMAN.
Prof. Astronomy and Mathematics, Rutgers
August 22nd, 1885. *College, New Brunswick, N.J.*

College Hill, *September 27th*, 1885.

Prof. A. E. Dolbear—

Dear Sir,—In reply to your request I will say that in the spring of 1878, while studying for the degree of Master of Arts at Tuft's College, I undertook a series of experiments in telephony, much of my time being spent in working with Reis's transmitters.

The results obtained were by no means uniform, but very often whistling, singing, and *talking* were reproduced with great power and clearness.

No intelligent physicist can for a moment fail to perceive the close similarity in every essential detail of Reis's transmitters and the more improved instruments of modern date. Each consists of a diaphragm, the vibrations of which alter the contact resistance of a point in an electric circuit.

The vibrations of the diaphragm alter the contact resistance at the given point by setting up a varying pressure at that point. This is all there is to the ordinary telephonic transmitter.

Secondary coils are merely accessories; they are not at all *necessary*. The assumption that carbon greatly alters the specific resistance under varying pressures is erroneous. It is true that the contact resistance of carbon points is more manageable than that of most other substances, but good transmitters can be made by employing contacts of almost any conductors.

There is no difficulty in making the unmodified Reis transmitter talk well with almost any good receiver.

The assertion that Reis instruments are necessarily "make and break" instruments can only be made by one financially biased or ignorant of physical laws.

That they do frequently "make and break" is true, but so does the Blake transmitter, if spoken to too strongly. It is far more difficult to adjust the voice to the Reis instrument than to the Blake, but when once the voice is adjusted the Reis talks.

The Reis receiver is not quite so satisfactory. His knitting needle receiver is mechanically poor. The needle should have been perpendicular to the sounding board, not parallel to it. Yet in spite of this defect the knitting needle receiver will talk with any good transmitter, Reis's included, and with some of the more modern transmitters I have heard very good talking.

Reis's electro-magnetic receiver was better; indeed it was identical in principle with Bell's 1876 form.

In conclusion, I would say that in view of the historical evidence, in view of the testimony of prominent scientific men still living who are contemporaries of Reis, and in view of Reis's instruments themselves, it seems to me nonsense to assert that Reis did not talk with his instruments, or that he did not design them to talk. Very truly yours,

(Signed) W. L. HOOPER,
Asst. Prof. of Physics, Tuft's College.

Princeton, *November 12th*, 1885.

Prof. E. J. Houston—

My Dear Sir,—An absence has prevented an earlier reply to your favour of October 21st.

(1). I have no hesitation in saying that in my opinion Reis was the inventor of the speaking telephone. No one who has carefully studied the literature of the subject can have failed to be convinced of the truth of this position, it seems to me.

(2). Actual experiment with apparatus constructed in accordance with Reis's description of his own apparatus, and with apparatus constructed by Koenig, and sold as an embodiment of Reis's invention, has in my hands transmitted speech, and in substantially the same way as the Bell apparatus when employing a Blake transmitter.

(3). Bell has set up a distinction among currents, and claimed the use of an undulatory current in the process of transmitting signals for the purpose of "multiple telegraphy," and subsequently he has claimed the use of such currents for the purpose of transmitting speech. The undulatory current was as old as the first experiments with dynamic electricity. It had been expressly spoken of and employed by others before Bell, and for a use exactly the same as that for which Bell claimed it in his celebrated patent which is now sought to be made the foundation of the great monopoly! (See Varley's English patent.) There can be no distinction in the nature of the currents employed by Reis and Blake, and there is no reason for any distinction between the current employed by Reis and Bell when his apparatus is used as a telephone.

(4). There is not the least reason to doubt that Reis did succeed, as he says he did, in transmitting speech; since it can certainly be done at present with his apparatus. And there is competent testimony that he did so succeed.

(5). The Reis-Legat receiver is a good one, and might be employed to-day in commercial business. Indeed, it contains everything which Bell's receiver contains, and acts in precisely the same way. One merely has to employ carbon for the contact pieces of the Reis transmitter, instead of platinum, to have an apparatus with which speech can be transmitted with certainty, and clearly. *The use of carbon is not the invention of Bell.*

(6). The modern transmitting telephones with variable contact are nothing but Reis transmitters with carbon substituted for Pt.

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I have not the least hesitation about taking any one of the positions here assumed with reference to the so-called invention of Bell. Yours very truly,
C. F. BRACKETT.

New Brunswick, N. J., *November 14th*, 1885.

Prof. E. J. Houston—

Dear Sir,—Yours of the 5th duly received. Not having made any extended study of the telephone in its historical aspects, I have been debating with myself how to reply to your questions seriatim.

I conclude to state what I have done and heard, as matters of fact. I have made a Reis transmitter with thin copper plate and platinum contact point. With this articulate speech has been transmitted most unmistakably, a Bell receiver being employed to receive.

That no absolute break of contact between point and plate of transmitter occurred I inferred from my failure to observe induction shocks while operating. The shocks are painfully prominent when transmitting music in the usual way. Nor could any spark be perceived while transmitting speech. Hence I believe that my Reis instrument does not give zero as minimum of current while transmitting *speech*. So far as my opinion is formed, it is that the *onus probandi* rests with those who assert an essential difference between the Reis transmitter and those of other patterns which operate by producing currents of varying intensity.

I write, as I said, what I can hold to as matters of fact, and I hope you will find it as pertinent to your purpose as would be seriatim replies to your questions. Yours respectfully,
F. C. VAN DYCK.

1346, Spruce Street, Philadelphia,
November 4th, 1885.

Prof. E. J. Houston—

Dear Sir,—Having some time ago made a careful study of the Reis telephone, and the literature on the subject, including his lecture in German, I shall be happy to answer your questions regarding his claim to the invention of the speaking telephone.

First. I most emphatically declare that in my opinion Reis was the original inventor of the speaking *electric* telephone.

Second. This question is somewhat analogous, and must be answered in two parts. The Bell telephone, as originally invented by Bell and used by him, is a magneto-telephone in which the current is developed by the vibration of the iron plate in front of the pole of the magnet in the transmitter, and is therefore unlike the Reis instrument. But the present telephone of Bell, in which a battery transmitter is used in connection with the Bell receiver, the electric current is "*manipulated*" (if I may use such a term) in precisely the same manner as in the Reis apparatus.

Third. This question is one which in my opinion no one can answer positively for the reason that we do not as yet know whether there is such a thing as a "current of electricity" or what takes place in a conductor during the passage of that force called electricity. Since this is so, we can neither say what form this so-called current takes in its passage through or upon the conductor. Even if we assume that there is such a thing as a "current," and that it is capable of assuming a shape, it is in my opinion not necessary for the transmission of articulate speech that this current should be an undulatory continuous one and such as Bell describes it, but may be an interrupted one provided the interruptions in the continuity are so small as to bridge over the residual sensation of the ear, *i.e.* $\frac{1}{16}$ — $\frac{1}{104}$ of a second. Moreover, this is *the* vital question in the law suits of the Bell Telephone Company against so-called infringers of the patent.

Fourth. The evidence of the contemporaneous literature on the subject as well as Reis's lecture, points indisputably toward the fact that he transmitted articulate sounds, and it is my opinion that with slight improvements in his apparatus Reis could have transmitted articulate speech.

Fifth. It is my opinion that the chief defect was in the want of sensitiveness in the receiver and not in the transmitter.

Sixth. The modern battery transmitter is identically the same as the Reis transmitter, with carbon instead of platinum for one of the contacts. In particular I will instance the transmitter of Berliner, of Boston, which was bought by the Bell Company.

Hoping that these answers will be sufficient for your purposes I will in closing refer you for further information to the expert testimony in the case of Bell *v.* Clay, in which you will also find all the important papers of the Reis literature.

Very truly yours,
C. SEILER.

Dickinson College, Carlisle, Pa.,
December 15th, 1885.

Prof. Edwin J. Houston, Phila.—

My Dear Sir,—Pardon my apparent neglect of your two communications in regard to the Reis telephone. It was not oversight, nor altogether want of time, and in no degree indisposition, but I happened to be present in 1865 at the trial of Prof. Reis's telephone at Giessen, in Prof. Buff's lecture room.

My recollection is not very clear as to the details of the apparatus or of the testing of it, as I was at that time more interested in many other things, persons, and places, but my recollection of the impression made upon me, and, as it seemed to me, on Prof. Buff and the others, that it was interesting and curious, perhaps, but not likely to grow into anything of great practical value. The Bell telephone at first created somewhat similar impression, but having acquired more interest in electrical applications in meantime, and electrical science being so much more advanced than in 1865, I regarded it as involving greater possibilities than I had done in case of the Reis instrument. In looking at the latter now, I cannot but regard it as simply born out of due season, a little too early to be appreciated and wrought out into a practicable instrument.

In answer to your interrogatories I would say then: I believe that Reis invented *a* speaking telephone as early as 1865, and that he succeeded in transmitting articulate speech at that time, and at the time I attributed the defects of the instrument, and in that, perhaps, reflected the opinions of others present, to the variable character of the contact of the transmitter, that seemed to be unavoidable in any instrument for the purpose. Regretting the delay, and hoping the above may meet your questions.

I am, yours truly,
CHARLES F. HIMES.

417, Walnut Street Phila., *November 21st*, 1885.

Prof. Edwin J. Houston—

Dear Sir,—My replies to your queries are as follows:—

(1). In my opinion Reis invented an electrical speaking telephone, but he was not the first inventor of that class of telephones. An extended and critical examination of many certified records and repeated interviews with Antonio Meucci, now of Staten Island, N.Y., have convinced me that he produced a practical speaking telephone as early as 1857.

(2). When the Reis instrument was operating as a speaking telephone, it worked substantially in the same manner as does the instrument known as the Bell telephone.

(3). I have never succeeded in transmitting sound by the use of an undulatory current (produced in the manner described in the Bell patent), and in my opinion it is impossible so to do, consequently I consider that when the Reis instrument transmitted speech, it must have been by the use of a current dissimilar to the undulatory described in the specification of the Bell patent.

(4). I can see no reason why Reis should not have occasionally transmitted words, and I consider the testimony relating to the performances of his telephone to be conclusive, especially when coupled with results which are occasionally obtained by the use of instruments made in accordance with the descriptions published contemporaneously.

(5). The defects of the Reis instruments seem to be chiefly due to crudeness of construction of both transmitter and receiver, but chiefly in the receiver.

(6). The "modern transmitting telephones of the variable contact type" are interrupters of the electric current. I have clearly demonstrated some time since that unless the current is interrupted, no transmission of speech (or sound) is possible; of course the interruptions must not be of such duration as to become evident to the ear, for in that case communication is prevented by the interposition of gaps which cut off a part of the representative impulses necessary to produce the desired sounds.

The replacement of one platinum electrode by a carbon point undoubtedly allows of a greater separation of the parts without an actual breach of contact, so that interruptions which would otherwise be of too great duration to allow of the transmission of a majority of impulses are bridged over by an elastic conductor of vapour of carbon.

The telephone of Meucci, to which I have made reference, was very similar to the present Bell receiver, and was used both for transmitting and receiving. It can be readily demonstrated that the result of the successful use of this magneto-electric device is the production of an interrupted and not an undulatory current.

The ordinary contact transmitter produces an interrupted current by breaking the continuity of the conductor, whilst the magneto transmitter produces a precisely similar current by causing momentary cessations of the current in a continuous conductor. Interruptions of the continuity of the current is an essential to successful transmission of speech with either sort of apparatus. Respectfully yours,
CHARLES M. CRESSON, M.D.

EXPERIMENTS WITH TRAMWAY MOTORS.

IN the discussion which followed the reading of Captain Douglas Galton's paper before the Society of Arts on Wednesday the 20th inst., and published at some length in last week's REVIEW,

Mr. W. H. PREECE, F.R.S., said he was a juryman at the Antwerp Exhibition, and though his official duties did not require him to inspect and report upon these tramcars, he took every possible opportunity of examining them, and being an electrician, of travelling backwards and forwards on the electric car. He was delighted to find that the anticipations he formed, at an early period of the exhibition, had been fully borne out by what Captain Galton had said. At the same time it was rather difficult to discover in what respect this particular car differed from others of a similar kind which had been experimented on in England. One very similar ran backwards and forwards for some time in the works of the Electric Power Storage Company at Millwall, and one designed by Mr. Reckenzaun had been running some time in Berlin. He tried to find out the special features of the accumulator used by M. Julien, but failed to do so. It was said to be formed on a framework of some unalter-

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able metal, but he did not discover what it was; he heard by a side-wind that it was nickel, but at any rate, as far as the performance and appearance went, he could see no difference between it and those used in England. As an electrician, he had seen very great difficulties in carrying out a system of tramways worked by electricity, but, like all other difficulties, experience and study succeeded in removing them, and he had the greatest confidence in the future use of electricity for this purpose, whether applied directly or by the aid of accumulators. Captain Galton, at the end of the paper, said that undoubtedly if it could be relied on electricity would be the best motor for tramways; and that was the way in which everyone spoke of it. But there was no power on earth used for the service of man which could be so certainly relied on as electricity. These doubts were due to the fact that the early applications of electricity were so striking in their character, such, for instance, as reproducing speech by the telephone, that they at once caught the attention of the public, who at once believed the thing was perfection before it had really reached the practical stage. He had no doubt we should yet live to see in London and the suburbs, the Antwerp experiments repeated on a much larger scale.

Mr. A. Reckenzaun said this was one of the most interesting and practical papers ever read on the subject of the mechanical propulsion of tramcars, but it would have been still more useful had the experiments been carried out on a line presenting more difficulties. It was very easy to travel on a level line, but very difficult to travel on an incline. For instance, if it required 2 horse-power on the level, it would take 4 horse-power to go at the same speed up a gradient of 1 in 75, 6 horse-power for a gradient of 1 in 37, and 8 horse-power for 1 in 25, which was not very serious after all. Again, the sharpest curve on the line at Antwerp was only of a radius of one chain, and he was rather surprised it was not made sharper. He had recently been running a car in Berlin, where he had received much more encouragement than in London, and he believed a fair amount of business would be done there before any start was made in England at all. There, one curve was 11 metres radius, and there were several of 15 metres. In the Antwerp tram it appeared there was a certain amount of noise caused by the chain gear, and this kind of gearing was not very practical in the case of a tramway where there was a deal of dirt to guard against. He had adopted a worm wheel, such as was shown on a large drawing of his tramcar on the wall. Many experienced engineers advised him not to use this gearing, but having arranged it so that the wheel dipped into an oil bath, and the whole boxed in, so that little or no dirt could find access, he found that there was not nearly so much loss by friction as had been stated, previous experiments having all been made apparently at low speeds, and showing an efficiency varying between 30 and 50 per cent. He found, however, that he got as much as 80 to 85 per cent., which was as much as could be got with a chain. He had two motors, so that the speed or power could be varied at will. One motor would propel the car along a level road, and it would run down an incline of 1 in 70 by its own momentum, which showed how little friction there was. The two motors in parallel arc would drive it up an incline of 1 in 18, and the two were used in series at starting, when the electric resistance was greatest, so that the current flowing then should be the smallest possible. With regard to the wonderfully lasting accumulators which it was said M. Julien had discovered, he would only say that if the plates lasted only six or eight months electrical cars would still be more economical than horses. Although the efficiency of the whole apparatus between the steam engine and the car wheels could not be taken at more than 30 to 40 per cent. (he reckoned it at 33), still it was economical to use electricity, because the accumulators only weighed 1¼ ton, and the whole of the rest of the machinery weighed half a ton, making 1¾ ton altogether, which compared very favourably with a locomotive weighing eight to ten tons. You could, therefore, afford to lose 60 to 70 per cent. of your motive power. He ought to say that he was much indebted to the Electric Power Storage Company, who had assisted him very materially in bringing this car to perfection. He had been working at it for four years, but it was only within the last twelve months he had arrived at a practical result. The first question was, to produce an accumulator which was light and at the same time durable and efficient. The main advantages of this system were, first, economy, and second, the electric car had the same appearance as those in general use, which could be easily converted, and at small cost. The wearing parts of the mechanism were very few, and could be easily replaced. The weight of motive power was less than two tons, distributed over two small bogies of four wheels each, so that the actual weight on a given section of the rail was less than that of an ordinary car resting on four wheels only. The propelling apparatus was invisible to the passengers; the motor was boxed in completely; it was practically noiseless, and free from danger. One man, not necessarily skilled, could drive the car, which could also be illuminated at night by the electric current. Of course, the maintenance of the permanent way would cost less than where horses were used, and the charging stations would occupy less space than the stables.

Mr. W. R. Rowan could not agree with the two previous speakers. There was no doubt that the most taking car was the electric motor, but the whole question from the first hinged on one word—economy—and the question would turn out to be, which was most economical, steam used directly in driving the car, or to produce electricity, which should then drive it. The electric car had all the advantages on its side as regarded appearance and other qualities which might be desired in a motor for towns, but he thought it would be difficult for the jury to decide on the question of economy. There were four main difficulties which he thought it would take electricians some time to get over. The first was the transmission of the power. The use of a belt or chain was not generally supposed to be satisfactory, and he had his doubts about the worm wheel. If electricians could discover a gearing which would enable them to work from a shaft running at 1,000, or even 500, revolutions a minute, those who employed steam would be very glad, because they could use it with small engines running rapidly. Such a style of engine was what naturally suggested itself for this purpose, but hitherto it could not be used on account of the difficulty in transmitting the power. The second difficulty was that of the accumulators; would they really last if knocked about daily in a tramcar. The trial at Antwerp gave very little information on that point, being short, straight, and level, so that they only had to be charged once a day. Had it been a line such as Mr. Reckenzaun mentioned, they would require charging four or five times a day. There was as yet no proof that the accumulators would stand, and if they had to be renewed even every year, the cost would be greater than that of maintaining a properly constructed steam-engine. On a recent visit to Brussels, he learned that the Company had voted 25,000 francs towards the establishment of a regular electric service on one of the lines there, in order to test this question; but he felt pretty confident that one or two years' trial would not lead to horses being superseded by electricity. The third difficulty was the charging of the accumulators. In running up steep grades, and with grooved rails, which added greatly to the friction, he believed the accumulators would have to be charged five times a day, which would be a practical difficulty. Lastly, if all these difficulties could be overcome, he doubted if they could work as cheaply as with steam direct, seeing that only 25 to 40 per cent. of the power would be utilised. The question of the power utilised, however, did not play an important part in tramway maintenance, the whole secret of mechanical tramway work would lie in having a motor powerful enough under certain circumstances; which would run very cheaply when it had little work to do, but which would work expansively, so that you could put on a second car and carry a large number of passengers when required; and up to the present he ventured to say there was nothing to compete with a simple form of steam-engine, where you had only to put a little more coal on the fire to obtain the necessary power.

Mr. Scott Russell agreed with a great deal of what Mr. Rowan had said with regard to using steam direct; it must be a question of economy, and however much the public liked it, you would never find a tramway company adopting electricity or compressed air unless it paid them. With regard to electricity, he understood from practical electricians that the theoretical loss from the engines to the accumulators, from them to the dynamo, and from that to the rail, was something like 75 per cent. as a minimum, and he was afraid unless accumulators were made much lighter, they would be found too heavy.

Mr. Scott Moncrieff said Captain Galton had pointed out what would be admitted more and more as time went on, that certain points, such as simplicity of construction, power of moving in either direction, applicability to existing lines, &c., were of vital importance, and especially that the motor should be self-contained for the purpose of locomotion in crowded thoroughfares. This was the first paper of importance on tramway traction independent of particular interests, and embracing the subject as a whole, and it was very satisfactory that it should be based on a series of practical trials such as those made at Antwerp. At the same time, he agreed that the trials were very unsatisfactory, for the reasons which had been pointed out. The absence of inclines and curves was a fatal objection, because the best motor at Antwerp might get a prize, on the strength of which it might be introduced in a place where it would prove a complete failure. He hoped that public attention being drawn to the matter would lead to similar trials being made in this country before long. Time did not allow of his referring at length to his own work in this direction, but he might say that his first series of experiments with compressed air was the means of inducing the Legislature to permit the use of mechanical traction on urban or suburban tram lines. In 1877, power was given, subject to the approval of the Board of Trade, for mechanical power upon a practically country line at Wantage, and also an urban line in the vale of Clyde, and his evidence with regard to the success of compressed air led the Parliamentary Committee to recommend the passing of a Bill sanctioning the use of mechanical power. In common with many others, he had been waiting for the ripening of public opinion with regard to the use of mechanical power other than steam. The pressure brought by the Board of Trade on inventors to produce something which would comply with their rules had been more or less relaxed, because no steam-engine had hitherto complied with these requirements all day long. During a certain period, or under certain conditions, the smoke and steam might be successfully suppressed, but after a certain amount of wear and tear it had been absolutely necessary for the Board of Trade requirements to be relaxed, if steam was to be applied to tramways at all. He could not speak as an expert in the matter of electricity, but its advantages, as regarded a self-contained vehicle of good appearance, were evident. Nothing surprised him more than the extraordinary amount of fuel used by the compressed air engine. It certainly bore no relation at all to the theoretical laws which bore on the conversion of energy from the boiler to

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the reservoir, and showed some egregious failure in the system. His own experience, as given in evidence in 1877, more nearly approached the Rowan engine, which stood at the head of the list for economy; but, as had been very properly said, if the proper motor were obtained, neither the public nor the companies would cut the matter so fine as to reject it on account of one or two lbs. of coal per train mile. He had urged before the Institute of Mechanical Engineers reasons for believing that in this particular case compressed air would be quite as economical as steam, the most obvious of these reasons being that a very large and powerful engine, embracing all modern improvements, and using a very small quantity of coal per indicated horse-power, might be employed. If such an engine only consumed 3 lbs. of coal, and there was a loss of 50 per cent. on the use of compressed air—which there ought not to be—you would get to practically the same economy as in the Rowan engine, at Antwerp, 5·42 lbs. Then the car itself, although somewhat heavier than an electric car, had still all the good qualities of a self-contained vehicle, capable of surmounting considerable inclines and going round sharp curves. He could not sit down without saying a word on the electric car described by Mr. Reckenzaun. He had long thought that the worm wheel had been a too much abused mechanical appliance, and was not astonished to hear that the loss from friction at high velocities was much less than had been generally supposed. He should be interested to know how this worked in actual practice, but thought from the appearance of the drawing, that it was too slight for the work it had to do.

Mr. B. DRAKE said there were one or two points in connection with the Electric Power Storage Company, which he represented, which he should like to mention. They not only used accumulators at their own works, but had supplied them for trials elsewhere, and in practical working it was found that, giving them the full charge, the efficiency in ampères was 75 per cent., and beyond that the loss in energy, expressed in watts, depended on the time at disposal to discharge them. When Mr. Reckenzaun tested them at the works, the power going into the accumulators necessary for each car was reduced to a minimum, and in those trials they were charged up rather quicker than they would be for lighting purposes, and there the efficiency was about 70 per cent. in watts. That experiment had been very carefully conducted, and might be depended upon. With regard to the duration, the same as had been in use for two years were now to be seen at the works; there was very little destruction of the plates, and what there was was from mere mechanical shaking about. They were all perfectly ready, and if they were wanted to-morrow for an electric car could be put into regular work. M. Julien claimed a good deal in the way of production of local action by his special arrangement, but if one went into the causes of local action it would be seen that, if pure peroxide and pure lead were used, there was no necessity to have any local action at all. They had left batteries standing for six weeks fully charged, and at the end of the time the power was practically equal to what was put in. Whether they were discharged in one week or six weeks, the loss was hardly appreciable. The car at the works, from one cause or another, had not been used for some months, but still they were able to show it that day running without having been charged or touched for months. It had been stated, on behalf of the compressed air car, that stationary engines more economical than any which could be used on a car were applicable; this would also hold good in accumulators with this additional advantage, that in the case of compressed air, assuming that from the moment you started you had by some mechanical arrangement to get over the gradual decrease of power from the air chambers, whereas with accumulators there was practically no loss of locomotor force, from the time of starting until the time when they had gone so low that for the sake of sparing the plates you should not discharge them any further.

Mr. M. HOLROYD SMITH said a good deal had already been said which it was unnecessary for him to repeat, and he only needed to clinch the argument. Mr. Rowan and Mr. Reckenzaun had made comparisons between accumulators and steam traction, the former pointing out that the difficulty with accumulators was that you had to take the power and convert it into electric energy, and then re-convert it into mechanical energy, and that there must be a loss in the transmission. With that he perfectly agreed; on the other hand, Mr. Reckenzaun showed that the tests at Antwerp were unfair on account of the car running on a level without curves, and that where 2 horse-power would be sufficient on a level it would have to be raised to 8 on a gradient of 1 in 25. Now, he wished to prove that, especially in the case of accumulators, that meant an excessive demand on the stored energy contained in them, and he would venture to prophesy that Mr. Reckenzaun would find that by the manner in which he was now working the accumulators they would very soon be worn out, and he did not see how a tram line could be worked economically if the motive battery in the car lasted only six months. However, he believed he had absolutely solved the question which Captain Douglas Galton had put before them, viz., that, whether electricity could be applied with certainty to the propulsion of cars. He was now doing that, day in day out, from morning to night, at Blackpool. He used electricity direct, and, therefore, there was no loss through the accumulators. The great question with regard to using electricity direct for street purposes was, how to do it with safety to the public, and until he laid down this line it had not been done, because one rail had been used for the positive, and the other for the negative current, or some side rail, which would be very dangerous to the traffic, had been applied. By conveying the electricity underground, and having a means of communicating with it in the car, it was possible to utilise it without any danger either to the public or the traffic. That point had been most carefully tested by Major Armstrong. The Major felt a little trepidation at first, and it was not until holding his hand he touched the surface of the centre channel and the surface of the rails at the same time, and could feel no possible shock, that he was satisfied of the fact. The cars were running every day except Sundays; the present being the off-season, there are only three, whereas during the season there would be ten, and, of course, the same plant had to be put down, and the same electrician, and standing wages had to be paid as if the whole ten were running. It was, therefore, very unfair to take the present experience as a test of what could be done, because when the whole of the cars were running it only meant a little more coal in the engine; but even now the cost was only half that of horsing. On the same line, before the electric plant was completed, horses were employed, and being just at the close of the season they were obtained from omnibus proprietors at a very low price, but still it was double the cost of electricity.

Mr. SCOTT MONCRIEFF asked what was the actual sum paid.

Mr. M. HOLROYD SMITH said it was rather less than 6d. per mile for the horses, but they were now doing it at half that price; when the whole ten cars were running it would cost about 2½d. per mile, including depreciation and interest on outlay. The length of the line was over two miles, the steepest gradient 1 in 40, and the sharpest curve one of 48 feet radius, curve and gradient at the same place. The point he wished to insist upon was the advantage of driving tramcars direct instead of using accumulators. He did not wish to argue against secondary batteries for tramcar work, for he thought they would serve a very useful and important purpose, by increasing the public confidence in electricity, and then they would be prepared to go the whole length, and use the direct current. At the same time, if you had to go up a gradient of 1 in 20 for a mile and a-half, and another of 1 in 30 for two miles, as was the case in some places in Yorkshire, it required some pulling up, and unless the amount of accumulators in the car were doubled, they would very soon be spent. Electricians knew that it was a very risky thing to quickly exhaust a secondary battery; you might charge them quickly if you liked, but it was a very awkward business to discharge them rapidly. The weight, therefore, would have to be increased, or their life would be shortened. Now, by his system, if the tramcar came to a hill, the man in charge only had to put on (? cut out.—EDS. ELEC. REV.) a little more resistance, and if necessary the whole power generated at the station might be taken to send the car up the gradient. He could not only take the car, but could draw another behind it loaded with passengers up the steepest incline. Although they had been working through wet, wind, and snow, and the whole line had been deluged with sea water, they had been able to work with a loss from leakage of not more than one ampère of current.

Capt. DOUGLAS GALTON, in reply, said he agreed with the comments which had been made on the line at Antwerp, which certainly did not represent those found in this country, but those who knew Antwerp would be aware that it was impossible to lay down a line there with steep gradients, and even sharp curves could not be made conveniently, having regard to other traffic on the boulevards. The full report of the jury would soon be published in a very complete form, and he hoped all persons would reserve their final opinion until then.

The CHAIRMAN then proposed a cordial vote of thanks to Captain Douglas Galton for his valuable paper, which was carried unanimously.

In our last issue we queried the weights of the accumulators as stated in the proofs of Captain Douglas Galton's paper which were used in connection with the electrical tramcar in the Antwerp experiments.

The following figures are given in the Society of Arts Journal and are, we presume, correct. The accumulator had 40 elements, divided into four series, each series communicating by means of wires fixed to the floor of the car, with commutators which connected them with the dynamo used as a motor.

There were two sets of these batteries or accumulators, one of which was being charged in the shed whilst the other one was in use. The exchange required 10 minutes, including the time for the car to go off the tramway into the shed and return to the tramway. This exchange took place after every seven journeys. Therefore, the two batteries would have sufficed for working the car over a distance of about 42 miles during 16 hours.

It may be observed that the first service in the morning would be performed by means of the accumulators charged during the afternoon and evening of the previous day.

Each element of a battery was composed of 19 plates, of which 9 were positive, 4 millimetres thick, and 10 negative, 3 millimetres thick. Each positive plate weighed 1·44 lbs., of which about 25 per cent. consisted of active material. Each negative plate weighed nearly 1 lb., of which one-third consisted of active matter. The weight of the metallic part of the battery amounted, therefore, to 1,846 lbs.; and the whole battery, including the case and the liquid, amounted to 2,464 lbs., which contained 499 lbs. of active matter, or about 20·25 per cent. The four cases in which the battery was contained were so arranged as to divide the weight equally between the wheels.

Two commutators enclosed in a box were placed on the platforms at the two ends of the carriage, so as to be available for moving in either direction.

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The accumulators were divided into four series of 10 double elements, which, by means of the commutators, could be united under four combinations, viz.:—

1st. 4 series in quantity—	1 in tension.	
2nd. 2 „ „ „	2	„
3rd.	3	„
4th.	4	„

Finally, a fifth movement united the four series in quantity, coupling them on each other, and putting the dynamo out of circuit, thus restoring equilibrium. When in a state of repose the handle was so arranged as to keep this latter switch turned on. The accumulators were arranged for charging in two series united in quantity, each containing 20 double elements. The charge was effected by a Gramme machine, worked by a portable engine. Each of these series received its charge during seven hours for the ordinary service of the car, and during nine hours for the accelerated service.

NOTES.

Electric Lighting in Copper Mines.—Messrs. Henry Bennett and Co., of Glasgow, have recently completed an installation of arc lamps at the Calânos Mines, Spain, belonging to the Tharsis Sulphur and Copper Company, Limited. The dynamo used is a Crompton 6 unit machine, and supplies current to six Crompton "D D" arc lamps of 3,000 C.P. each, driven by an 8 horse semi-portable Marshall engine. The object of the company in adopting the electric light is to enable them to work night and day at excavation work, so as to get down to the coppe1 ore as quickly as possible. The installation is of a very complete nature, and was carried out in a highly creditable manner by Mr. A. W. Hine, one of Messrs. Bennett's electricians.

The Electric Light and Detective Work.—Several men were charged at the Thames Police Court last Saturday, with being concerned in the theft of meat from the shop of Mr. F. G. Chapman, butcher, of 345, Mile End Road. Mr. Chapman is an amateur electrician, and in this instance made good use of his knowledge in detecting and procuring the apprehension of the thieves. For several years he has had an installation of electric lighting on his premises, a gas engine being used during the day for charging accumulators and driving a sausage machine, and at night for lighting the front of his shop by means of an arc lamp, incandescent lamps supplied by the accumulators lighting the interior of the shop. Having suspicions as to considerable losses of meat, Mr. Chapman early one morning last week secreted himself at the back of the shop and watched, with the result that he saw his shopman hand quantities of meat to a number of men who entered the shop one after the other, before the shutters were raised. He had arranged with two detectives to have an electric light at the top of the house, and connected with the place where he was concealed; he signalled to the detectives by switching on the light as the men left the shop with the meat; the detectives encountered them and they were arrested. Terms of imprisonment varying from fourteen days to three months were inflicted on the prisoners, the shopman receiving the severest sentence.

The Electric Lighting Act.—It was announced at the beginning of the week that Mr. Stanhope would shortly bring in a Bill to amend the Electric Lighting Act. How far that intention has been interfered with by recent events in Parliament we are not yet informed.

Electric Installation on a Christmas Tree.—At an entertainment given by the Glasgow Board of Lunacy at the Bothwell District Asylum, the Christmas tree was lighted up by Messrs. Henry Bennett & Co., of Glasgow. The installation consisted of 20 20-C.P. Woodhouse & Rawson lamps, supplied by current from a Groves patent dynamo. The entertainment was brought to a close with a dance, the position of the lamps being altered to light up the hall.

The Electric Light in the Royal Navy.—Commander Charles G. Robinson, of the torpedo school ship *Vernon*, has made his half-yearly survey of torpedo stores and gear and electric light stores and fittings at Devonport and Keyham Dockyards.

Electric Lighting of Factories.—Messrs. Wilson, Scott & Co.. manufacturers, Hawick, recently had their works fitted up with the apparatus necessary for the introduction of the electric light, and so successful have the experiments been, that the firm contemplate an extension of the installation so that the whole works may be lighted by the new illuminant. The lamps, some 160 in number, are on the incandescent principle. This is now the second factory in Hawick lighted by the electric light, and, besides, there are three dye houses and two private residences illuminated by the same means.

Electric Lighting of a Church.—The central electric lighting station of Sir Coutts Lindsay, from which the Grosvenor Gallery and several other adjacent premises are illuminated, has extended its system to the well-known church of St. George's, Hanover Square, which is now lighted by Swan incandescent lamps arranged in three large electroliers, each containing some 30 lamps, and a number of separate branches throughout the church: The central station is situated at the back of the Grosvenor Library where machinery of 600 horse-power, is installed. The furthest reach of the system at present is the Café Royal, near the foot of Regent Street.

Domestic Electric Lighting.—Messrs. Henry Bennett and Co., of Glasgow, have recently fitted up an installation at Underwood House, Denny, the residence of Mr. R. Brown Smith, of Messrs. Smith & Wellstood, the well-known stove manufacturers. The installation consists of an Elwell-Parker dynamo, thirty 20 C.P. lamps, and 25 "E. P. S." accumulators. The machine is driven by a Tangye engine, which is also used for pumping water for household purposes. The fittings and globes are all of a very neat design, and when the current is switched on the result is very effective.

The Damage to Telephone Wires.—It is stated, and "official authority" is credited with the origin of the statement, that the cost to the United Telephone Company of the late snowstorm in repairs and compensation for damage by the breaking of wires, posts, &c., will be not less than £10,000. This estimate, however, scarcely harmonises with the statement which the secretary of the company sent to the papers immediately after the storm, that the damage was "comparatively slight."

Curious Fulfilment of a Dream.—A shocking accident occurred at Messrs. Rollo's engineering works, Liverpool, on the night of the 22nd inst. Christopher Edwards, who had charge of the electrical apparatus with which the place is filled, had just replaced a carbon burner when a lamp fell upon him. He was picked up insensible and taken to the hospital, when it was found he had lost his eyesight. A fellow workman is stated to have dreamt the night before that Edwards was handing him a battery when it knocked him down, and that he was carried away insensible.

The Phonograph.—Mr. Edison is stated to be now busily engaged in perfecting the phonograph, which he has scarcely touched since 1878. He believes that the instrument has a great future before it for commercial use, and he intends to apply it to that purpose. As an instance, he says that bankers, merchants, lawyers and editors, can dictate to it at their convenience. An office boy would then make it repeat all that has been said, which he could transcribe at his will. The stenographer, says Mr. Edison, is an expensive institution in an office; this will take his place as a complete registering machine.

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Dynamo Tests.—We agree with Mr. Crompton that the subject of dynamo tests is of great importance, and we hope that the offer of his firm to subscribe £50 towards promoting such a desirable object will be followed by others. His remarks on the work of the Royal Agricultural Society are perfectly true, and we believe that the dynamometer used by that society would give more trustworthy results than that (the Tatham) employed by the Franklin Institute.

The School of Submarine Telegraphy and Electrical Engineering.—Mr. W. N. Tiddy, who has long been connected with this school, has recently found it necessary, owing, we are sorry to hear, to failing health, to resign his position of joint-manager, leaving the institution entirely in the hands of the gentleman with whom, for the last year or so, he has shared the management, Mr. Wm. Lant Carpenter, B.A., B.Sc., F.C.S., &c. The school has made steady progress ever since its establishment in 1868, and there is no reason to fear that its advance in the future will be less satisfactory. Mr. Carpenter is an Associate Member of the Council of the Society of Telegraph Engineers and Electricians, and popularly well known as the author of "Energy in Nature," and as a writer and lecturer on scientific subjects. It is claimed for the school that it affords instruction and training both theoretical and practical, special pains being taken to teach the pupils, and not merely to let them learn. And when it is remembered that the period of instruction is only twelve months, it will be admitted that to turn out so many successful pupils must necessitate a great amount of painstaking attention on the part of the manager and tutors in the case of each individual student. In the prospectus it is stated that in the last examination four-fifths of the pupils obtained their certificates, and the report of the examiner was, "The result is a highly creditable one to the school, and shows that the course of instruction is very complete."

The Cost of Gas in America.—We have just examined a table containing a list of 96 places in America and the price paid for gas per 1,000 cubic feet in each locality. From this it appears that the highest price charged is 16s. 8d., and the lowest 3s. 9d. The average price reckoned from the total number of places, comes out nearly 7s. 6d. per 1,000 cubic feet. This will partly explain the wonderful business in electric lighting which is carried on in the States, the gas there being from two to three times as costly as in this country.

Electricity for Elevated Railroads.—Mr. Frank J. Sprague has recently been lecturing before the Boston Society of Arts on "The Application of Electricity to Propulsion on Elevated Railroads." Much interesting matter is contained in Mr. Sprague's paper, which we may perhaps in a future number reproduce, although we have nothing in this country to liken to the New York elevated roads.

Field Magnets for Dynamos.—Mr. Carl Hering, whose paper on "The Commercial efficiency of Incandescent Lamps" we published in our last issue, is explaining in the *Electrical World*, "How to wind the magnets for shunt, series, and compound machines."

The Tramcars at the Antwerp Exhibition.—The Brusssels correspondent of the *Times* writes:—"The jury deputed to award the prizes in the competition of self-acting tramway cars for street use on the occasion of the Antwerp Exhibition has conferred on the Electric Company at Brussels the diploma of honour; on Messrs. Black, Hawthorn & Co. (Wilkinson system), of Newcastle-on-Tyne; W. Rowan, of Berlin, and Krauss & Co., of Munich, silver medals; and on the Beaumont Compressed Air Locomotive Company a bronze medal. Visitors to the Exhibition will recollect that the cars of the different systems ran along the Boulevard des Arts, the principal artery of communication between the terminus and the Exhibition."

Torpedo Boats.—A new torpedo boat, steered by means of electricity, has been patented by Mr. Horace P. Griswold, an American. Its motive power is derived from an engine using a compressed gas contained in a reservoir. The steering arrangements are ingenious, and the boat may be seen in section in the *Electrical World* for the 16th inst.

The Pole Frightened the Wall!—In the Lord Mayor's Court, on Tuesday, the Recorder and a jury heard the case of Harris *v.* United Telephone Company. The plaintiff, a dentist in the Mile End Road, sought to recover from the defendants £8 15s., expenses he had been put to in repairing a wall, which, it was alleged, was damaged by one of the company's poles. Mr. Harte, for the plaintiff, said his client was applied to some five years ago by the defendants to allow a pole to be placed in his garden. He consented, and a pole 60 feet in height was placed in a corner of it. It carried 38 telephone wires, and was supported by stays, and came within a few inches of the wall. For some years no rent was charged for it, but subsequently an arrangement was come to that the plaintiff should have telephonic communication between his surgery and his private house, the company agreeing to pay him £2 10s. a year for the use of the garden for their pole, and the plaintiff to pay £5 10s. for the telephone connection, the company undertaking to be responsible for the erection, maintenance, and removal of the pole. In May last the plaintiff had notice from the local authorities that the wall had become unsafe, and had to pull it down and rebuild it, at the cost now sued for. The cause, it was alleged, was that the stays, having weakened the wall, made the pole lean towards it. The Judge: But the pole never touched it. Mr. Harte: No, my Lord. The Judge: Then the wall got frightened? (Laughter.) Mr. Harte: No, not frightened, except it might be said it became frightened yielding to undue pressure. (Laughter.) The defence was a denial that the injury was caused by the pole in any way; but that it was the result of the unsound condition of the wall. The jury found a verdict for the plaintiff for the amount claimed.

Fires at Electrical Works.—On Sunday morning an alarm of fire was raised at the India-rubber, Gutta-percha and Telegraph Company's premises at Silvertown, and it was found that the lower part of a large four-floored building had become involved. Two rooms on the ground floor, used as an instrument room and lavatory, caught fire and got well alight. The *employés* of the premises got four of the hydrants fitted to the place into operation, but although they succeeded in cutting off the spread of the flames to the upper part of the building, they could not prevent severe damage being caused to the lower portion.

On Monday morning a fire broke out on the premises of Messrs. Walter T. Glover & Co., electrical wire and cable manufacturers, of the Springfield Lane Cable Works, Salford. A shed in which one of the processes in connection with the manufacture of the wire is carried on was in flames; a large tank containing tar was also on fire, and this burned with great fury. The flames were extinguished in about twenty minutes. The building in which the fire originated was destroyed, and the damage, including the stock which has been destroyed, will amount to about £300.

The Blackpool Tramline.—At the Society of Arts meeting on Wednesday week, Mr. Holroyd Smith spoke very hopefully, indeed, one might almost say with a too positive assurance, regarding the success of his electrical tramcar system. At Blackpool, he cannot lose a great amount of power through the heating of his conductors, but on longer lines this source of loss would form a serious objection. Apparently Mr. Smith has no belief in secondary batteries; there is, however, but little doubt that the time will come when even he must admit their express adaptability for tramcar propulsion. In the meantime Mr. Smith deserves every encouragement to persevere in his efforts.

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Glasgow Institution of Civil Engineers.—At the fourth meeting of the Glasgow Association of Students, held on the 22nd inst., the first of a series of lectures was delivered by Principal Jamieson, F.R.S.E., A.M.I.C.E., on "The latest developments of electric lighting." The lecturer explained a number of interesting details comprised in the lighting arrangements on board of the ss. *Mohican* and *City of Bombay*, referring specially to the introduction of Faure's cells into the system adopted on board the former vessel.

Proposed Cable between America and Australia.—A Reuter's telegram from New York, dated January 25th, states: "A telegram published here states that two gentlemen from Australia, one of whom has already arrived at San Francisco, and the other is on the way, will shortly proceed to England with the object of promoting the scheme for laying a telegraphic cable between San Francisco and Australia."

Overhead Wires.—In the House of Commons on Monday, Sir H. Tyler asked whether attention had been drawn to the failures of telegraph and telephone wires used overhead in the metropolis during the recent snowstorm, and to the accidents which had been occasioned thereby; whether a return of these failures and these accidents would be prepared and presented to the House; and whether any steps would be taken to prevent this constantly increasing danger to all persons using the streets of the metropolis. Lord J. Manners: My attention has been drawn to the failure of telegraph wires during the recent snowstorm, and I am glad to be able to state, in reply to the question of the hon. member, that no case of accident to any human being has been caused by the wires belonging to the Post Office. A large proportion of the overhead wires in the metropolis do not belong to the Post Office, and the Department has no means, therefore, of furnishing the return asked for. The policy of the Post Office for many years past has been to substitute underground for overhead wires in London, and also in other large cities, wherever the extra expense involved could be justified, and since my appointment I have given renewed instructions on this point. I may add that the mileage of postal telegraph wires in the metropolis, on the 31st of December, was 9,832 miles, of which 9,005 miles, or about $\frac{11}{12}$ths, were underground wires. In the eastern central and western central postal districts, which comprise the half of the metropolis, there were only 44 miles of overhead wires the property of the Department. As the House is aware, a Select Committee was appointed last Session to consider the law relating to the control over telephone, telegraph, and other wires, and made a report, but it has not been considered desirable to take action in the direction of the course recommended in that report.

Fire Alarms.—Captain Shaw, in his annual report upon the work of the Metropolitan Fire Brigade, states:—"During the year there has been some development of means of communication, and now the following lines are in working order. Orders have been issued for the completion of the system, and it is probable that within the next few months the whole of the work may be executed:—Twenty-eight telegraphs between fire stations; 38 telephones between stations; one direct fire alarm between stations; 42 alarm circuits round fire stations, with 263 call points; three telegraphs to police stations; 18 telephones to police stations; 13 telegraphs to public and other buildings; 20 telephones to public and other buildings; 13 direct fire alarms to public and other buildings."

The Etève Engine.—As some of our readers may be desirous of seeking information respecting this engine, which should mark a new era in the production of motive power, we may mention that the sole manufacturers and licensees for Great Britain and Ireland, the Australian and other colonies, are Messrs. Priestman Brothers, of the Holderness Foundry, Hull, and 52, Queen Victoria Street, London.

Mr. Bruce's Balloon Signalling System.—By direction of the War Office, experiments in army signalling of a novel and interesting character were begun on Saturday evening last at the Army Signalling School, Aldershot, under the superintendence of Major Thrupp, when Mr. Eric Bruce, son of Major-Gen. Bruce, attended to exhibit his balloon signalling apparatus, which has already been described by us. It is understood that further experiments with this system will be carried out.

Primary Batteries.—In response to our note asking for information as to the best form of battery for use with electrical jewellery, Messrs. Craven and Elworthy have submitted to us a double cell of their own construction, which appears to be admirably adapted for the purpose.

The Gravet Slide Rule.—We hear that the Gravet slide rule, which we described some three years ago, and for which Mr. Wm. Farrar, of Leeds, is the sole agent in this country, has been adopted by the senior classes at South Kensington, the Board of Works, and the War Department, and that it is very largely used by electrical firms, electricians and telegraphists, to whom it is especially useful.

Electric Locomotion.—Mr. Reckenzaun this week resumes his articles on Electric Locomotion, and shows that it is neither scientific nor practical to use varying resistances for reducing power. At the same time he clearly states the advantages of employing multiple motors which can be connected up in parallel, in series, or singly used.

Messrs. Woodhouse and Rawson.—The Supply Department or Merchants Business at 11, Queen Victoria Street, London, E.C., of Messrs. Woodhouse and Rawson's electrical business for the sale of to merchants, shippers and the trade, of all descriptions of electrical goods, was transferred on the 26th inst. to the Woodhouse and Rawson Electric Supply Company of Great Britain, Limited, with a registered capital of one hundred thousand pounds (£100,000). The management will continue to be under the personal supervision of Messrs. O. E. Woodhouse and F. L. Rawson, who will act as managing directors.

We are requested to state that the above arrangement will not affect the business of Messrs. Woodhouse and Rawson of 11, Queen Victoria Street, London, E.C., who will continue to undertake electric light installations as heretofore, nor will it interfere with the business of the Woodhouse and Rawson Electric Manufacturing Company, Limited, of Cadby Hall Works, Kensington, which will continue the manufacture of electrical goods.

New Postal Telegraph Office at Teignmouth.—It is anticipated that the above office, which forms part of a new and handsome block of buildings, will be completed and be ready for occupation by Lady Day. The main office in the new building is 40 feet by 20 feet, and is lofty, well ventilated, and excellently lighted. Besides the other usual offices, a special room is to be set apart for the postmaster (Mr. Walton), communicating with his private residence.

The Lighting of Eaton Hall.—On the occasion of the recent visit of H.R.H. the Prince of Wales to Chester, Eaton Hall, the residence of His Grace the Duke of Westminster, whose guest the Prince was, was lighted electrically by the Electrical Power Storage Company, of 4, Great Winchester Street, E.C., who sent E.P.S. accumulators fully charged from their works at Millwall.

The Electric Lighting Bill.—We are authorised to state that Mr. Hugh Watt, M.P., Chairman of the Maxim-Weston Electric Company, Limited, will give notice on Thursday next of his intention to introduce a Bill to amend the Electric Lighting Act of 1882.

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A Sensible Suggestion.—At a meeting of the Portsmouth Town Council, on Tuesday, it was agreed to invite tenders for a Town Hall, in which will be centralised all the public offices. Councillor Beale suggested that arrangements should be made for the building being lighted with the electric light, but it was resolved to leave this matter to a sub-committee, which was appointed to visit other large towns and present a report thereon.

Ship Lighting.—On the invitation of Messrs. George Smith and Sons, a large number of ladies and gentlemen visited the new screw steamer, *City of Bombay*, on Tuesday evening, when the vessel was lighted by electricity. The steamer has been fitted with the single-wire system of electric lighting, and the result has proved entirely satisfactory. We shall give further particulars of this in our next issue.

The West African Cable.—A shareholder of the Brazilian Submarine Telegraph Company, who writes in our correspondence columns, is curious to learn what has, no doubt, puzzled many others with regard to the latest project of Messrs. Pender & Co., and that is, what is the precise nature of the arrangement between the promoters of the new undertaking and those who were responsible for the existence of the West African Telegraph Company? The exclusive right to land cables at St. Vincent, which the Brazilian Company claims to have acquired, is the right, we expect, possessed by the West African Telegraph Company, and which will fall to the new company when it completes the purchase of the existing cables from the other.

Telegraph Revenue.—The receipts on the telegraph service from April 1st, 1885, to January 23rd, 1886, amounted to £1,405,000, against £1,420,000 received from April 1st, 1884, to January 24th, 1885.

The Telegraph and Storms in America.—Heavy snowstorms have recently caused considerable damage to telegraph and other wires in America, severing communication between the eastern towns and California. Communication has now, however, been restored.

NEW COMPANY REGISTERED.

Woodhouse and Rawson Electric Supply Company, Limited.—Capital £100,000 in £10 shares. Objects :—To take over the business of the supply department of Messrs. Woodhouse and Rawson, of 11, Queen Victoria Street, so far as relates to the United Kingdom, and to become sole agents for the sale of all articles manufactured by the Woodhouse and Rawson Manufacturing Company, Limited. Signatories (with one share each): —*O. E. Woodhouse, *F. L. Rawson, W. L. Magen, all of 11, Queen Victoria Street; J. H. Ward, 113, Lavender Sweep; *E. H. Burnett, 160, Cromwell Road; E. Manville, 38, Sutherland Avenue, Maida Vale; Carl Von Buch, 17, Cavendish Place, W., the latter being appointed secretary. Directing qualification 100 shares. The signatories whose names are preceded by an asterisk, are the first directors. Registered 25th inst., by Mr. Sydney Morse, 5, Lime Street Square. Registered office, 11, Queen Victoria Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

British Electric Light Company, Limited. — The annual return of this company, made up to the 7th inst., was filed on the 19th inst. The nominal capital is £100,000 in £10 shares. 7,396 shares are allotted and the full amount has been called thereupon. The calls paid amount to £73,250, and the sum of £710 is considered as paid up upon 155 shares.

Electrical Power Storage Company, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 25th inst. The nominal capital is £200,000 in £1 shares. 147,450 shares have been issued, upon each of which £1 has been paid. Since the last return the capital has been reduced from £800,000 in £2 shares.

Telephone Company of Austria, Limited. — The annual return of this company, made up to the 12th inst., was filed on the 19th inst. The nominal capital is £100,000 in £5 shares. 11,710 shares have been issued and the full amount has been called up. The calls paid amount to £750, and £57,765 is considered as paid upon 11,153 shares. The calls unpaid amount to £35.

Electric Locomotive and Power Company, Limited. —The statutory return of this company made up to the 12th inst., was filed on the 19th inst. The nominal capital is £50,000 in £5 shares. 2,149 shares have been taken up, and upon 2,007 shares the sum of £3 has been called, and upon the remaining 142 shares the sum of £2 has been called, the calls paid amounting to £3,221. Registered office, 6, Great Winchester Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Eastern Telegraph Company, Limited.

THE twenty-seventh half-yearly general meeting of this company was held at the Cannon Street Hotel on Thursday, the 21st inst., Mr. John Pender, chairman of the company, presiding.

Mr. Geo. Draper, the secretary, having read the notice convening the meeting, and the minutes of the previous meeting having been read and confirmed,

The Chairman said: The revenue for the six months ending 30th September, 1885, amounted to £331,420, against £309,569 in the corresponding period of last year, showing an increase of £21,851. The return on our investment in the Eastern and South African Company shows a falling off for the half-year of £1,950, the dividend having been at the rate of 7 per cent. instead of 8 per cent.; on the other hand, our returns from the Black Sea companies show an increase of £771. I am pleased to observe that our Indian traffic, which has been stationary for some years, shows some signs of reviving, but the main increase of traffic in the six months' account which we are now considering, is owing to the military operations in Egypt and at Rangoon. Our Australian, China and Tonquin traffic was very good during the greater portion of last year, but since the middle of December there has been a considerable falling off. We may, however, hope that the reduction is only temporary, and that there will before long be a general expansion of business of which the company will certainly have the benefit. The expenses amounted to £86,935, an increase of £1,928. We have opened up new stations in Parliament Street, Westminster, and at Perim. There is also a full six months working at Katacolo and Patras, against two months at the former and one at the latter in the same period last year. There has also been an increase in the number of clerks, the total in September, 1884, being 526, and in September, 1885, 562, an increase of 36. Promotions have also been made in certain cases for high proficiency and length of service. There have been considerable sanitary measures at the training station at Porthcurnow, and repairs at Carcavellos, Alexandria and Aden, and food allowances have been made to the stations at Suakin and the Island of Perim. The clerks at these places have great difficulty in obtaining good food, and so a special allowance was made them. With reference to the items shown separately on the revenue account, that under the heading of patents shows a decrease of £1,888, an important reduction due to the expiration of Sir Wm. Thomson's patents, to which I referred last year in complimentary terms. I believe we could not possibly have brought submarine telegraphy up to the high position it occupies now as a great commercial power had we not had the advantage of Sir Wm. Thomson's patents. He has reaped a very fine harvest from them; the patents have now expired, and we are going on experiencing the advantages which I have mentioned and which are increasing rather than diminishing. The next point is the depreciation of cable stores in London, £2,588. A large stock of cable has been depreciated this half-year, and ample provision has been made for the depreciation of the London office, furniture, &c., necessitated by the change of offices. The directors, taking the view that the ships are the tools for repairing our cables, have decided to again make a special provision for

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this fund. I may remind you that we were able to charge the cost of the *Volta*, one of our ships, to this fund, and we hope the revenue will continue sufficiently good to enable us to reserve £5,000 each half-year, so that we can apply the total cost of our new ship, the *Mirror*, in the same way. We shall then have added two ships to our fleet without having increased the capital account. That is what we are considering at the present time, and we take you into our confidence. Our great object, as you know, is to keep down our capital, and, as far as possible, strengthen our system from revenue without unduly crippling our dividends. I may mention that so anxious are your directors to maintain our system efficiently, and to be ready, almost at an hour's notice, to make a repair, that we have established what we call tanks at our important stations in the Mediterranean and Red seas, where we keep a certain stock of cable, and we have generally a ship lying within a few hours of these tanks, so that instead of a ship coming to England to ship supplies we are enabled to ship within a few hours of where the interruption takes place. It may be seen on reference to Abstract C. that full details of the work done by our ships are given. They have been constantly employed during the half-year, and, in addition to the numerous important repairs effected, the *Volta* has laid a duplicate Chio-Syra cable, and completed the final section of the Greek cables, which entitles us to the prolongation for ten years of the subsidy granted by the Hellenic Government. There are also the expenses attending the charter, outfit and the cancelling of the charter of the ship *Ardmellie*. The vessel was chartered at a time when the relations between this country and Russia were very much strained owing to difficulties in Afghanistan. Had war broken out, it would have been absolutely indispensable to have had our ships stationed in the Mediterranean in case of the stoppage of the Canal. Political affairs becoming settled, we have cancelled the charter of the *Ardmellie*, and decided to have a new ship to be prepared for emergencies. For similar reasons we have decided to increase our tank accommodation; this will put the company in an immensely better position, and we may possibly be useful to Her Majesty's Government in emergencies. The shareholders are aware that the company was of great service to the Government and to the Commanders in the army and navy in recent operations, and the same thing may happen again. The total of the reserve fund is now £444,875; after charging all expenses, including income-tax on the net revenue and interest on debenture stock and preference shares, we are enabled to pay a dividend and bonus of 6 per cent. per annum and carry forward £32,549, against £30,369 for the corresponding period of last year. There are points in the report to which I am bound to refer more particularly to-day. First, the Conference at Berlin during the months of August and September. I had the pleasure of being present there with your managing director, Sir James Anderson, and several members of our staff. At that conference we had a very important part to play, and the reason we had such an important part was from the fact that the submarine companies represented at that meeting owned something like 100,000 miles of submarine cable, costing about £35,000,000 sterling. The whole of the submarine cables belonging to the Powers of Europe represents something like 7,300 miles, or something like a million and a-half of money. I may say that the value of the cables represented at the conference exceeded the cost of the whole of the land line systems represented there. You can, therefore, see that the position which we held was one of great importance; one that required considerable intelligence to defend, and required a considerable amount of power and influence to impress upon the gentlemen attending that conference how important it was for them to maintain the submarine system as far as it was in their power to do so. The submarine system benefits not only this country; there is no country in Europe that it does not benefit to precisely the same extent, measured by the amount of commerce which it has with other nations scattered over the world. While we have conferred this enormous boon upon the countries engaged in the commerce of the world, we have derived no special benefit; we were not even allowed to vote at the conference. We must have had a very good case or we could not have maintained our position as we did. At the last Conference the great object of Germany was to get something like a universal rate established for submarine telegraphy on the Continent. The Minister of Posts and Telegraphs, a man of great power and intelligence, had been successful in establishing a universal postal system, which I believe has been of enormous benefit to the world at large. He thought it possible to introduce the same thing into telegraphy, but found it was a very different thing. The consequence was that, while he brought the other powers to reduce very materially the rates of Continental messages, and thus interfered considerably with our rates in the Mediterranean, still, after all, we found ourselves at the end of the Conference in this position: reductions were made, first, to India, involving a sum of something like £23,000; and the reductions which we were obliged to make in the Mediterranean amounted to something like £17,000. Consequently, the gross amount we had to submit to in reductions was something like £40,000. That is a large sum in one sense, but not a large sum in another. I believe that we see something of the dawn of better trade; we see it moving in more parts of the world than one, and there is no greater barometer of trade than our telegraph system, and we believe that the reduced rates will contribute very largely to the increase of traffic, and to that increase of traffic we look in a very short time to recoup ourselves for the loss which more immediately we sustain. Therefore, I do not look upon that reduction in any other light than casting bread upon the waters, and you will find a return after many days. Having remarked upon the want of support from the Press in their battle at Berlin, and also upon the liberality of the Press when constrained to make use of the cables, the chairman continued: The next question I must draw your attention to, is the extension on the Western Coast of Africa. We have all read and watched with considerable interest the great interest taken in what was once called the dark continent by continental powers. Portugal has been very ambitious and very sanguine about the returns to come from the West Coast of Africa; Germany has been looking to that part of the world, and has made selections there, and is about to establish settlements; France has not been behind; but after all, I believe that England holds probably the most important and valuable parts on the West Coast of Africa. The Government, looking to the development of our settlements on that coast, invited tenders for a telegraph system to connect this country with the West Coast of Africa. We have always considered it important that we should follow the English flag, for wherever the English flag floats trade is likely to be developed, and as we have ever been the pioneers in opening up telegraphy all over the world, we thought it would be wrong not to include in our programme the West Coast of Africa. For this reason we have our line to Lisbon, at Lisbon we join on to the Brazilian Company, which is also an English company, and managed very much in harmony with the Eastern Company; at St. Vincent we make a departure for the West Coast of Africa. We tendered, in connection with the Brazilian Company, for this line which the Government desired, and we obtained the concession, a concession giving us £19,000 per annum. The agreement, which the solicitor will read to you, enables us to control the West Coast of Africa and the important traffic there, and without any real cost to this company. It will be a feeder to our line, and all that we are likely to be asked to invest is £75,000 in shares, which we will keep in our safe in very much the same way as we have managed our South African Company, which has been very successful. We shall pay for these shares by Eastern Company's debentures issued at 4 per cent. In conclusion, the Chairman moved the adoption of the report and accounts.

The Marquis of Tweeddale seconded, and the motion was agreed to.

Lord Sackville A. Cecil and General Lord Alfred Paget were re-elected directors, and Mr. Henry Dever was re-appointed auditor.

The Solicitor having briefly described the nature of the agreement referred to,

The Chairman moved: "That the agreement submitted to this meeting, dated 19th January, 1886, and made between the Lords Commissioners of Her Majesty's Treasury of the one part, and the Eastern Telegraph Company and the Brazilian Submarine Telegraph Company of the other part, with reference to the establishment of submarine telegraphic communication between St. Vincent (Cape de Verde) and the British possessions on the West Coast of Africa, be and is hereby approved and confirmed; that the arrangements proposed by the board for transferring the said agreement to the African Direct Telegraph Company, Limited, and the subscription by this company of a sum not exceeding £75,000 to the share capital of that company, and the raising of the amount required for such subscription by the issue of £4 per cent. debenture stock of this company, be also approved and adopted; and that the board be authorised to do all such things as they may deem necessary and expedient on this company's behalf to give effect to the agreement and arrangements aforesaid."

The Marquis of Tweeddale seconded this resolution, which was then put and carried unanimously, a vote of thanks to the chairman following.

Direct United States Cable Company, Limited.

The seventeenth ordinary general meeting of this company was held at the Cannon Street Hotel, on Friday last, under the presidency of Mr. John Pender, chairman of the company.

Mr. J. W. Fuller, secretary, having read the notice convening the meeting,

The Chairman said the revenue for the half-year to the 31st December, after deducting out-payments, amounted to £38,115, and the working and other expenses, including income-tax, but exclusive of cost of repairs, absorbed £16,632, leaving a balance of £21,483 as the net profit of the half-year, making with £10,734 brought from the previous half-year, a total of £32,217, which had been appropriated as follows. Interim dividend of 3s. per share to 30th September, £9,106 10s.; dividend of 3s. per share to 31st December, £9,106 10s.; set aside to reserve fund, £8,037; balance carried forward, £5,967. Total £32,217. The revenue showed a reduction of £30,709 as compared with the corresponding period of 1884, owing to a reduction of tariff and competition. The working expenses compared favourably with those for 1884, the expenses in London showing a reduction of £227, while those at the stations, notwithstanding the establishment of three new offices, at Glasgow, Bristol, and Havre, were only £129 in excess. Taking the expenditure on the whole, and including the increased income-tax, there was a reduction of £226 in favour of the half-year under review. The amount of £353 15s. 5d. for expenses of the steam ship *Pouyer Quertier* was a final payment, the agreement for the steamer having expired on the 8th November last, and had not been renewed. The reserve fund, with its interest,

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and the amount set aside from revenue, after being debited with £3,362 12s., for cost of repairs to cables, now amounted to £320,000. The present market value of the company's investments was higher than the cost to the company. These were some of the details of the last half-year; but there was one remarkable figure that he had given them, and which, no doubt, they would ask him to make some remarks upon. That item was the revenue, which showed a reduction of £30,709 as compared with the corresponding period of last year. The reduction arose simply from this: instead of five cables in the Atlantic, which would be ample to do the work at the present moment, there were ten cables; consequently, each earned its proportion, and as the Atlantic revenue had never at any time exceeded a million—it had gone down instead of advancing—every additional cable laid took away from the existing cables. The position they occupied was strictly that they had more cables in the Atlantic than were required to do the work, and consequently, unless they had an increase in the traffic or an enhanced tariff, he did not see much prospect of getting increased dividends. But, eventually, common sense must prevail, and those who had recently put cables down, would find that they had not such a return as they desired, and would endeavour to bring about a better return. He did not wish to discourage the shareholders with a bad view; their company occupied, perhaps, the best position of any company in the Atlantic telegraph business. They had a reserve fund of £320,000; their affairs were managed on the most economical principle, and the directors had, during the nine years they had conducted the business, paid them 5 per cent. up to the present time, and had added a large amount to the reserve. That reserve meant £5 7s. per share, and if they took that at the present value of the shares, it did not represent half the value of their property. That was a very grand position to occupy, and although the prospect at the moment was not a bright one, they were in a better position to fight the battle, if it were necessary to be fought, than any of the other existing companies. He hoped there would be a stop to additional cables, and that before he met them again, six months hence, such arrangements would be made as would make the tariff remunerative, and bring back a better state of things. He disliked, above all things, what he called throwing away money, and the reduction of 4d. per word, which was made when the Mackay-Bennett cables came into the market, benefited no one: it did not benefit the sender, it did not increase the traffic, it had not benefited anyone, consequently, it was simply throwing £200,000 into the sea. He was loth to throw more money into the sea, and should like to bring about an understanding without what he called a fight. If they could bring it about without a waste of money, it was so much more desirable, so much more business-like, so much more in accord with common-sense, and he believed that when those who were opposing them looked at their balance-sheet, they must see that their investment was not producing such a return as they were entitled to expect. He had prepared their balance-sheet, and knew perfectly well that the cable did not pay. The Western Union, in the same way, laid two cables, for which there was no more necessity than to put a fifth wheel to a cart; and they had found their mistake. He hoped that the result would be that they would all come together and arrive at such a conclusion as would enable them not to throw away money, but to bring more money into the pockets of the shareholders. With these remarks, he begged to move that the report of the directors, dated 13th January, 1886, together with the statement of accounts for the half-year to 31st December, 1885, annexed thereto, be and the same are hereby adopted.

Mr. Wm. Ford, a director, seconded the motion.

Mr. Jackson suggested that a good investment of the reserve fund would be in securities of the Gas Light and Coke Company, which was paying 12 per cent. on ordinary stock, and which had been established 50 years. Experience would make fools wise, and he thought there had been a great deal of folly in regard to Atlantic cables. He thought, therefore, they might look forward to a gentle increase—nothing very extraordinary, but still an increase—in the dividends. For the very safe and solid position the company occupied they were indebted to the chairman, and they might look forward with confidence to the results he had indicated. He wished also to make a few observations on the great services which he (the chairman) and the esteemed managing director of the Anglo-American Company and Mr. Fuller had conferred on Atlantic telegraphy in fighting its battles at the Berlin Conference. For five years they had really a concession, and they had maintained their present rate of tariff. When they remembered that the Eastern Telegraph Company had to sacrifice £40,000, they must see that to this company the loss of that sum, or its proportional amount, would be a very serious thing indeed. Mr. Jackson then expressed his satisfaction that the chairman had lost his seat in Parliament. Mr. Pender had achieved distinction enough in telegraphy, for there could be no question that he was in the van, and perhaps he would take the loss of his seat as no loss.

Mr. Cuff was glad to hear the chairman say he had drawn up a balance-sheet of the Mackay-Bennett cables, as perhaps that would enable him to say whether the gross traffic for 1885 was an increase or a decrease over that of 1884.

The Chairman thanked Mr. Jackson for the kindly remarks he had made. If any gentleman could make any suggestion in regard to any sound investment which would give them a trifle more than that which they already got, the directors would be only too glad to listen to it. They had talked of the very investment of which Mr. Jackson had spoken; but, as they knew, there was a very considerable gas scare two or three years ago, when the electric light came to the front. He believed in electricity, and that the electric light must become the light of the future. His impression was that there was a dawn of greater prosperity both in the East and in America. And when the cycle of good times came nothing would benefit in greater proportion than the telegraph systems with which they were connected. At the Berlin Conference their interests were looked after by himself and Mr. Fuller. That was a very important gathering; all the Powers of Europe, and nearly all important Colonies, were represented. The interest of submarine telegraphy was larger in value than the whole of the telegraphic land-line systems of Europe; but at that conference they had no vote. They were allowed to speak, to argue, to bring all their facts to bear upon the different representatives. But he might say that while there was a strong determination on the part of the Minister of Posts and Telegraphs at Berlin (Von Stephan, a very intelligent and a very powerful man), to do for telegraphy what he had done, and done successfully, in the universal postal system, he found it would not answer. Had he carried his point it would have made a great difference in submarine telegraphy. Whether it was through their strong position, through the representations they were enabled to make, or not, they held their position, and he believed they left the Berlin Conference with the submarine cables in a better position than they had ever before occupied. Mr. Jackson had good-humouredly referred to his losing his seat. He had had no idea that he was going to lose it; but he might tell them honestly that he had never lost anything with so little regret. He had got to that period in life when there was no necessity for ambition in that direction; things had been going rather fast lately, and he had not been disposed to follow. He felt that he could not consistently have followed the party in some of the extreme views recently put forward, and therefore he was perfectly satisfied as things were. With regard to Mr. Cuff's query, the volume of traffic between this country and America was less last year than in that previous. That was easily accounted for: they all knew that America had been passing through a very severe commercial crisis; some of the greatest houses had been shaken to their very foundation, and the result of the clearance in America would, he believed, looking to the American character, be renewed action, renewed enterprise, and that result must tell upon the telegraph system. Therefore he looked to an increase of traffic in the Atlantic, and had no doubt they would have their share of it.

The resolution approving and adopting the report was then put and carried.

Mr. Jackson moved a vote of thanks to the chairman and the directors.

Mr. Griffith seconded, and the vote was unanimously accorded.

The Chairman suitably acknowledged the compliment paid him, and brought the meeting to a close.

The Western and Brazilian Telegraph Company, Limited.

On Thursday last, Mr. Andrews (one of the directors) presided at the 13th ordinary general meeting of the shareholders, at Cannon Street Hotel.

Mr. R. M. Cunningham, secretary, having read the notice convening the meeting,

The Chairman said: Gentlemen, in the absence of Sir Henry Wolff, the directors decided to rotate the chair amongst themselves, and it is owing to that that I am in the chair to-day. However, the duty which I have to perform is not altogether a disagreeable one, because I have to draw your attention to a more satisfactory state of things, I am pleased to say, than it has been our fortune to experience for some time. You will all of you have noted, no doubt, that the revenue for the year ended September, 1885, is not a low one, showing a great increase upon the revenue of the previous year and the year before that, and it is, in fact, the largest revenue that the company has ever earned since the beginning of its business. We should have had a better statement to lay before you but for the adverse condition of the exchange in Brazil, in consequence of which the company has suffered to the extent of £10,000. I am afraid, for the present, there is no remedy for that state of things. We have earned 20 per cent. more money, not only without any addition to the working expenses of the company, but with an actual diminution in them of £1,700. There are some gentlemen here who have not been in the company from its commencement, and who are unaware of the peculiar expenses that existed when this board took office. You had then a spinal cord, if I may so call it, 3,700 miles long, and of this no less than 2,700 miles were diseased; you had an old unsuitable type of strand cable. The effect of that was the necessity for keeping the ships upon the spot in case of needed repairs. It was the cause of constant breakages to our lines and imperfect working, and consequently small revenues. The present directors were brought in as doctors to cure that state of things if they could. They had not the Bank of England at their backs, as you know, and they had to proceed by degrees. The system has been improved by degrees, as their work has gone on by degrees, and at present we have reached a very satisfactory position, when we can really see the end of this business. We have renewed all that bad stuff, 2,700 miles—no less than 85 per cent. of the whole length. Now, that has been done without asking for additional capital, or without going to anybody outside to water what there was. It has been done by the patience and encouraging aid which the shareholders have given to the directors. The 15 per cent. which still remains to be renewed

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extends to about 400 miles. The ship is out with 200 miles on board, with the object of substituting that for the length of bad cable which may still exist on the revenue-earning portion of the cable. Of course the directors have considered the condition of the ships. We think we can do with a different class of ship, and we think we shall see our way presently to reduce expenses under the head of shipping. There is a diminution, you will observe, this year, as compared with last, of £950. The outcome of the legacy that was left to us will be in a year or two represented by sheathed cable all the way. Of course we could not have done this work also without something in addition to the support which the shareholders gave us, and that was a renewal fund, which came to hand at the right moment. I hope the shareholders will always back up the board of directors to have a renewal fund. The shareholders may depend upon it that the directors do not recommend more money to be placed to the reserve than they think is absolutely necessary. There is another matter, which is a delicate one, but which I ought perhaps to refer to. Some shareholders are aware that recently certain exchanges of ideas have taken place between this company and the authorities in Brazil, and other parties interested in the cable communications between this country and Brazil, with a view to some sort of arrangement. There has always been, I think, a state of more or less suspended negotiation between us and these interests. There are no positive propositions. The interests are exceedingly complicated, and the whole arrangement, if any arrangement should come out of it all (which you must not understand me as saying I believe will be the case), but the whole arrangement would be exceedingly difficult to bring about, although there is no doubt that it might be brought about. I think you will be satisfied when the result of the negociations is known, that the directors have done their best for the company. We have very little more to say now, except to draw your attention to the present position of the company. The present position is a nearly-completed metal-covered cable the whole distance; the probability of lessened expenses; the certainty of a largely increased revenue which we put before you; and the further certainty and presence of the declaration of a dividend of 2¾ per cent. I have nothing further to do except to move "that the report and balance-sheet to the 30th September, 1885, be and the same are hereby approved and adopted."

Mr. H. Weaver (one of the directors) seconded the motion.

Mr. Guesdon said he should like to know who were the tenderers for the new cable, and whether the tender accepted was the lowest or not; and if the lowest tender was not accepted, the grounds upon which it was refused. Was the £1,500 still divided amongst five directors, because he did not think Sir H. Wolff could be present much. With regard to the negociations, he thought action should have been taken earlier.

The Managing Director (Major Wood): I took action in this matter as soon as I knew of it.

Mr. Guesdon asked, further, whether the negotiations were between the Brazilian Government and this Government, and he wanted to know whether there was anything of advantage to the company likely to come out of these negociations.

Mr. Swinton thought the shareholders all agreed that the expenses of that company were extravagant, and he indorsed the opinion of Mr. Guesdon, that a great deal of information was needed upon the matters to which he had alluded. He thought it was extravagant to spend £7,000 in home expenses. If £1,500 was considered only an adequate amount for the directors' services, they might reduce the number of directors, and then he thought £1,000 a year would be ample for fees.

Mr. Pain enquired if the board intended to fill the vacancy caused by the permanent appointment of Sir Henry D. Wolff in India. Would they, if they filled that vacancy, ask the shareholders to nominate someone, or would they elect someone themselves?

The Chairman: As to the negociations that are going on, I need scarcely say that the directors in their position as your representatives, can do nothing to commit you to terms, without, not merely coming forward to consult you, but without submitting to you the whole terms and being ruled by, and having to act upon, the decision that you come to. Mr. Guesdon asked whether we had gone by the process of tender for the new cable. We have, and we have been enabled (fortunately the tenderers have been respectable and solvent people)—we have been enabled to accept the lowest tender. With reference to the expenses of administration. Of the £7,000, £1,500 of this was on account of circumstances of an entirely exceptional character, which would not be coming forward again. One gentleman regrets that we have not given a larger dividend; another gentleman objects that the directors' fees are excessive. The gentlemen of this board had nothing to do with the inception and carrying out of this company. They have had to deal with a state of things of which the shareholders appeared originally to have approved, and which bore within them the very seeds of disaster. In fact, if you had not had the present board, which you elected to undo the mischief of its predecessors, I think the probability is that the company would have ended its transactions in a very disagreeable place.

Mr. Swinton suggested that they should have only three directors instead of five. He thought that three would do the work as well as the present five, especially as one was absent very frequently.

The Solicitor, replying for the chairman, said that the salary of the directors and their number were fixed by the articles of association; and the shareholders should have made themselves acquainted with those facts when they took shares. The number could be reduced by special meetings of the shareholders for that purpose.

After some further remarks, the chairman put his motion, which was carried; and Messrs. William Stratford Andrews and D. H. Goodsall having been re-elected directors of the company, the latter gentleman took occasion to suggest that the whole matter of getting the money back from the promoters of this company should be dropped. He believed that had it not been for the presence of Mr. Cunningham (the secretary) and Major Wood, this company would have gone into liquidation.

Mr. J. Weise having been re-elected auditor of the company's accounts, the proceedings, which had lasted about two hours, terminated.

Brazilian Submarine Telegraph Company, Limited.

LORD MONCK presided on Thursday last week at an extraordinary general meeting of the members of this company, held at the Cannon Street Hotel, for the purpose of considering, and if thought fit approving and confirming, an agreement made between the Lords Commissioners of Her Majesty's Treasury of the one part, and the Eastern Telegraph Company, Limited, and the Brazilian Submarine Telegraph Company, Limited, of the other part, being an agreement for the establishment of submarine telegraph lines between St. Vincent (Cape de Verde) and certain British possessions on the West Coast of Africa, and arrangements with other companies incidental thereto, and authorising the board of directors of the Brazilian Submarine Telegraph Company to give effect to such agreement and arrangements, and raise and apply moneys of the company for the purposes thereof.

Mr. Richard Collett, Secretary, having read the notice convening the meeting,

The Chairman called upon the solicitor to the company to enumerate some of the provisions of the agreement, which was signed on the 19th inst. It specified that the cable in question was to be laid by the 19th August, 1886, the company to connect it with their old line at St. Vincent, and that Her Majesty's Treasury should from the completion of the cable pay during the 20 years succeeding an annual sum of £19,000 as subsidy; and there was also provision made for the payment of the subsidy during periods of repairs. The agreement was not to be assigned except to a company who would be able to fulfil the requirements of the agreement. There was also another provision for the Government taking possession of the line in case of war, by paying compensation.

The Chairman then said: Gentlemen,—We have asked you to come together to-day in order to get your assent and sanction to the agreement which has been outlined to you by Mr. Chapman. It is virtually an extension of our system of telegraphs. This matter has occupied the attention of, and given a good deal of labour and trouble to some members of your board for nearly three years. We understood, some time in 1883, that it was the intention of the Government to connect the settlements on the West Coast of Africa by telegraph with England, and as the most convenient—and, indeed, unless an independent line of telegraph were made—the only way of communication with them by means of existing lines was through our system, we were deeply interested in seeing that no stranger got hold of the communication. We have been continually in communication with the Government for more than a year on the subject. It was referred to a committee consisting of Sir James Anderson, Mr. Broderick, and Mr. Fuller, to conduct the negociations in connection with the members of the Eastern Telegraph Board. You will see the reason for that, because the Eastern Telegraph cable, in point of fact, constitutes a portion of our system. Our telegrams only depart from Lisbon; and we cannot send any messages from London which are going to St. Vincent, or Madeira, or Brazil, without sending them through the Eastern Telegraph Company from England to Lisbon. Therefore, the Eastern Telegraph Company, equally with ourselves, are interested in securing telegraphic communication with West Africa. Well, after a great deal of negociations, about two months ago we came to an agreement with the Government that they would give us an annual subsidy of £19,000 for 20 years to complete the communication with Bathurst and St. Vincent, and the different British settlements southwards of the Niger and the Cameroons. Having completed that arrangement, we then considered the best way of carrying it out; we came to a conclusion with our friends of the Eastern Telegraph Board that we would form a new company, in which the Eastern, our own, and the Telegraph Construction and Maintenance Company, should be allies; and that it should be an independent company, because none of the three commands the whole line, and could not work it without introducing into the management of their own concerns an independent person, which would not be convenient. I should state that all the traffic of the new line is to be conducted through our office, and that our managing director is to be managing director of the new line, so that we shall have the control of the business, although the board which manages that business will consist of members who are not, properly speaking, members of the Brazilian Board. You will recollect that our system starts from Lisbon. Our first station is at Madeira, and our second great station is at St. Vincent, from which this new line of telegraph is to set out. Therefore, every message that goes to the West Coast of Africa must necessarily travel over these two sections of our line. Under the arrangement we have come to, we shall have one-third of the net earnings of this new line itself. That being the case, we come to the manner in which the money is to be got. It is proposed that we

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and our partners, the Eastern Company and the Telegraph Construction Company, should what is called "finance" this new company—that we should provide them with the amount of their capital, and that that amount we should raise by debentures on our own property, to the extent of one-third portion on the part of each—one-third from the Eastern, one-third from ourselves, and one-third the Telegraph Construction Company. But it is not proposed—and we have acted under the best financial advice—it is not proposed to raise by share capital the whole of the cost of this line. You will recollect that this new company is to have a subsidy for 20 years of £19,000 a year; and we propose that the balance of the cost of the cable, beyond the share capital to be raised, which will be equally divided between the three companies, and will amount to £75,000 each—the balance of the necessary cost of the cable beyond that will be raised by debentures of the new company's, secured in the first instance by the subsidy of £19,000 a year, and secondly by the whole of the property of the company, and will be guaranteed by the three allied companies. The subsidy is amply sufficient, if paid for 20 years, to raise the entire amount required, and to provide a sinking fund for its payment. If we let in any stranger it is probable the line would be prolonged to Brazil, and a competition dangerous to our interests would arise. There is one other matter, which does not affect this transaction that I know of, but I think it right to bring it before your notice. When we proposed to duplicate our cable, at the first meeting, I recollect that we told you that we should have to raise £250,000 by debentures to supplement our renewal fund in the duplication of the cable, and the duplication was entered into on that supposition. Fortunately we were able to duplicate the cable, and had only to raise £150,000 to do so. So that, after paying your share of the new cable, you will be £25,000 better off than you expected to be after renewing the Brazilian cable. The Chairman then moved, "That the agreement submitted to this meeting, dated the 19th January, 1886, and made between the Lords Commissioners of Her Majesty's Treasury of the one part, and the Eastern Telegraph Company, Limited, and the Brazilian Submarine Telegraph Company, Limited, of the other part, with reference to the establishment of submarine telegraphic communication between St. Vincent (Cape de Verde) and the British possessions on the West Coast of Africa, be and is hereby approved and confirmed; that the arrangements proposed by the board for transferring the said agreement to the African Direct Telegraph Company, Limited, and the subscription by this company of a sum not exceeding £75,000 to the share capital of that company, and the raising of the amount required for such subscription by the issue of debentures of this company, be also approved and adopted, and that the board be authorised to do all such things as they may deem necessary or expedient on this company's behalf to give effect to the agreement and arrangements aforesaid." In concluding, Lord Monck intimated that they had acquired landing rights from the Portuguese Government, so that there was no physical difficulty in the way of their carrying the agreement into execution.

Sir James Anderson seconded the resolution.

Mr. Griffith wished to be informed of the length of the cable, what was the entire amount of capital to be raised, and what amount of money was to be paid for the cable. They would have £75,000 worth of shares thrown upon them. Would it not be possible to offer them to the shareholders of the Brazilian Submarine Company at par, or some other price of advantage alike to the shareholders and the company? It would not then give the directors overwhelming power; and, as they would then have some money, they might be enabled to offer the 4 per cent. debentures at a better price. He would also like to know whether the 4 per cent. debentures lasted for only 20 years or longer.

Mr. Geo. Barham pointed out that the Eastern Telegraph Company, which carried the traffic about one-twentieth of the entire distance, was nevertheless to be paid the same as the Brazilian Submarine—one-third of the net earnings.

Mr. Blewett: Is it not a fact that we have already a cable from St. Vincent to Bathurst?

The Chairman: Yes; that is ours.

Mr. Blewett said that cable had been laid by another company, but he took it that the Brazilian would purchase that, in order to get rid of competition.

The Chairman, in answering the various questions, said the total distance this new cable will cover will be 3,117 miles. The total capital required for the new company stands—share capital, nominally £300,000; practically we expect that the whole work will be done for about £460,000, of which £250,000 will be provided by debentures of the new company, and the balance, £210,000, in shares. The nominal share capital is to be £300,000, but we expect that it will be done for £210,000. That is the estimate we have made upon the best advice that we could obtain. With reference to offering the shares to this company at par, I do not see what advantage it would be to the company. The shareholders are the owners of the shares; whatever profit there is will be carried to the credit of the company, and the credit of the company means the credit of the shareholders. There will be debentures issued of this company at 5 per cent. These will first be offered to the shareholders of this company.

Sir James Anderson said that the Eastern Company owned the whole of the share capital of the East African Company, and the Brazilian had two cables to Lisbon and were likely to have more. They did not care to have strangers coming in without their having something to say for maintaining the Cape business.

The Chairman then put the resolution, which was agreed to, and the proceedings ended.

The Lancashire Maxim-Weston Electric Company, Limited (in Liquidation).

THE liquidators of this company, Messrs. Thomas Whitworth and John Brown, called a meeting of the shareholders, which was held at the Cannon Street Hotel, on Thursday, the 21st inst., for the purpose of laying an account before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of. The liquidators presented the following report to the meeting:—The liquidators were appointed at the extraordinary general meeting of the company, held on the 13th March, 1884, with the understanding that the whole of the company's assets and liabilities should be transferred to the Maxim-Weston Company, under the 161st Section of the Companies Act, 1862. Meetings authorising this proposal were held on the 26th May and 10th June, 1884, but on the 14th July the Maxim-Weston Company declined to carry out the transfer in consequence of legal objections.

No alternative was therefore left to the liquidators but to realise the assets and distribute them among the creditors. The accomplishment of this has been attended with great difficulties.

The actions which had been pending against Messrs. Harding and Dadson for unpaid calls were at length brought to a satisfactory compromise (19th February, 1885), on terms which are detailed in the balance sheet. The late company's solicitors instituted proceedings to obtain their costs which had been incurred on these actions previous to the liquidation, amounting to £160 19s. 10d in full, which necessitated a change of legal advisers, and which resulted in their taxed costs being allowed by the Court on the 29th April, 1885.

The claim of the Maxim-Weston Company for £10,000, remaining unpaid on the price of the concession, was allowed by Vice-Chancellor Bacon on the 12th June, 1885.

The decision of the Court was also obtained in July, 1885, with respect to the item of directors' fees, amounting to £1,279 16s. 6d. Admiral Sir E. A. Inglefield and Earl De la Warr having put in a claim for their proportion of this amount, viz., £639 18s. 3d., they were permitted to claim the dividend on £28 7s., which amounted to £4 17s. 11d.

We regret that the sale of the concession which was ordered by the Court on the 12th June, 1885, should have produced so disappointing and insignificant a return, and can only account for this extremely unsatisfactory result and for the loss on the realisation of the plant, by the depreciation in the value of all electric properties during the last two or three years.

Mr. Whitworth presided, and briefly explained the circumstances which had led to so prolonged a liquidation, after which a resolution approving the action of the liquidators was moved and agreed to. There were only three or four shareholders present.

Cuba Submarine Telegraph Company, Limited.

THE report of the directors for the half-year ended December 31st states that the gross receipts, including the balance brought from last account, amounted to £14,966, and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the amount expended on cable repairs) to £6,325. The dividend on the preference shares will absorb £3,000, and leave £5,641, out of which the directors recommend a dividend on the ordinary shares at the rate of 7 per cent. per annum, tax free, £41 being carried forward. The sum of £1,920 has been charged to the reserve fund, being the balance of the payment made to the contractors as per contract on the shipment and laying of the Cienfuegos-Santiago cable in 1881. The total payments in respect of this cable now amount to £21,252, all of which has been provided for out of revenue, leaving only £3,750 per annum payable for the remainder of the period, viz., to February 17th, 1893, subject to the continuous working of the cable. The fund in the hands of the company on account of the contractors towards meeting any repairs now amounts to £4,902.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held on Friday, the 22nd inst., it was resolved (after placing £25,000 to the credit of the renewal fund for the quarter ending 31st December, 1885), to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on the 5th February next, the declaration of the following dividends:—1. A balance dividend of 10s. per cent. upon the ordinary consolidated stock for the year ending 31st December, 1885. 2. A balance dividend of 20s. per cent. upon the preferred stock for the year ending 31st December, 1885; both payable on the 6th February next, less income tax. After paying the foregoing dividends there will be a balance of about £4,000 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £1 5s. per cent. on the ordinary consolidated stock, and £2 10s. per cent. on the preferred stock, for the year 1885.

The Brazilian Submarine Telegraph Company, Limited.—This company gives notice that the coupons on its five per cent. debentures, due 30th instant, will be paid on and after that date, at the Alliance Bank, Limited. Coupons must be left three clear days for examination.

German Union Telegraph and Trust Company, Limited.—An interim dividend of 5s. 9d. per share was payable, free of income-tax, on the 20th inst. to shareholders registered on the 15th inst.

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TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 22nd were £2,450, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended January 22nd were £8,091.

CORRESPONDENCE.

Secondary Batteries.

Some time back you did me the honour to publish a letter respecting secondary batteries. The point dealt with was: "Do the E.P.S. positive plates sulphate with overcharging?" My experience led me to answer in the affirmative. Experiments have been continued, and always with the same result, but I have found that the sulphating is not due to overcharging directly, but indirectly through the bad form of separators employed, being India-rubber blocks on which powder may settle. When the process of overcharging is carried on, much gas is given off, which disintegrates the surface of the plates, and the powder and scale, instead of falling to the bottom of the cell, which would do no harm, remain in considerable quantities on these India-rubber blocks, and thus a continual discharge ensues in the cell itself. In time, this becomes very large, it being impossible to keep such a cell charged to a maximum, and the plates sulphate. Hence this trouble, and an important one, might be completely remedied by making the separators rubber slips running top to bottom, and, therefore, with no ledge for the powder to settle on.

The type of plates used here are the "hanging" ones, and, without wishing to flatter the E.P.S. Co., I can say that every disadvantage which their earlier plates suffered under are now absent. There is not the slightest tendency to buckle, or to sulphate (except under the circumstances mentioned), and they retain their charge well.

If only better separators could be employed, nearly perfection would be attained. Of course, the limit of charging and discharging current is a disadvantage, but it is not an easy matter to remedy this with a small area of surface on or in the plates. To avoid straining the cells, arrangements are in use rendering it practically impossible to charge or discharge too fast.

4-Pole Dynamos.

For a few words on the advantages of 4-pole dynamos. More than 4 poles complicate a machine, unless very large, and tend to induce currents of a wasteful nature, and, therefore, these remarks are restricted to dynamos with 4 poles.

1. They run slower, because the armature must have a considerable diameter in order to apply the 4 poles.
2. They are cheap to make, because the work is much the same as in a 2-pole machine, and the weight of the magnets, being divided, they are easier to handle during manufacture.
3. Because they are capable of better ventilation.
4. And, as a consequence, the density of current in the armature wire may be greater, lightening the weight of the armature and making its resistance lower.
5. Consequently, such a machine will have a good efficiency (if well proportioned in other respects).
6. By altering the F.M. wires so that the machine shall become a 2-pole one, raising one pair of the brushes, and the speed as before, half the current at twice the E.M.F. may be obtained. For some purposes this is useful.

In any case, the advantages of a 4-pole machine over a 2-pole, as generally now made, are chiefly of a mechanical nature, and for lasting power it is this which requires attention, for it appears to me that the electrical part was perfected years ago, and all progress has gone in the mechanical direction ever since.

David Salomons.

Broomhill, Tunbridge Wells,
January 25th, 1886.

The Bell Telephone Patents.

I herewith send you the decision of the Secretary of the Interior as to the propriety of having the legality of the Bell patent investigated by the Attorney-General of the United States, who then, if in his judgment a *prima facie* case be made out against its validity, may institute legal proceedings before one of the Federal courts to vacate said patent.

The effect in the United States of the vacating the Bell patent cannot well be judged of. It may result in establishing Elisha Gray as the inventor of the speaking telephone under his *caveat* of 15th February, 1876, or it may happen that the telephone will be free to the public so far as the principle of it goes, leaving patentees their rights to their respective inventions. I have not changed the opinion I have so often expressed in my letters to your excellent REVIEW, and still maintain that Bell was not the inventor of the speaking telephone, but that Reis was the first inventor who constructed speaking telephones. I do not claim for Reis that he made an efficient commercial instrument, but the instruments he made contain all the elements, both scientific and mechanical, necessary in a speaking telephone. I hold, however, my opinion that Bourseul in 1857 described an efficient telephone, but he never made one, so far as I have learned.

Bell, no doubt, has a just claim to the use of an undulatory current in a telephone, unless the liquid transmitter of Gray's caveat be held valid.

That great bugbear in telephones, the undulatory current, is, no doubt, serviceable in the telephone; but I hold that an intermittent current produces better results, for the obvious reason that the variations of the strength of the current are very much greater than can possibly be the variations of the strength of an undulatory current. I am of opinion that the use of the undulatory current in the telephone arises from the difficulty of making an instrument which will cause makes and breaks in the circuit sufficiently rapid. That articulate speech can be produced by intermittent impulses of electricity has been demonstrated by Professor Cross, of Princeton College, and by myself.

I will add, also, that I have had made several transmitters, some with platinum contacts, some with carbon contacts, some with carbon and platinum contacts; and they have been working for the past six months, the articulation being clear and distinct, and the tone loud. The makes and breaks are produced by the action of the speaker's voice on a tympan. The platinum points give the best results.

What will be the effect upon the Bell patent in England if the Bell patent be declared void in the United States? The U.S. patent was issued March 7th, 1876, and Bell's English patent filed December 9th, 1876.

Unless the Patent Act of 1873 has repealed that part of the old Act which declared a patent taken out in England subsequent to the taking out of the same patent in a foreign country to be void when the foreign patent became void, then Bell's English patent must fall from the date of the voidance of the patent in the United States.

W. C. Barney.

New York, *January 15th*, 1886.

The Commercial Efficiency of Incandescent Lamps.

I have read with great interest your article on the "Commercial Efficiency of Incandescent Lamps," in last Friday's issue. During the last four years I have

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made a large number of tests of all the incandescent lamps I could get hold of: and have recently been comparing them by means of a similar formula to that given in your article, but with this difference, the first part of my formula gives the efficiency with no regard to price, thus, $\frac{e}{746}$ (using the same letters as in yours), the second part gives the life and price combined $\frac{P}{C.P} \times \frac{p}{L}$ the whole expression being $\left(\frac{e}{746}\right) + \left(\frac{P}{C.P} \times \frac{p}{L}\right)$.

Another point of difference is the price per H.P. per hour. This I took for purposes of comparison at 1d. instead of about 2½d. as in the American tests. This, of course, makes a very great difference in the ultimate results obtained by the method I used and that used in your article last week; but the general conclusions to be drawn from both methods do not differ, viz., that the best commercial lamps are not those that have the highest efficiency, but rather those which have the longest life; the best efficiency for ensuring a long life with reasonable economy being, according to my results, about 3·4 to 3·6 W. P. C.

I have found that a quick way of comparing lamps is to try what is the highest potential they can bear before breaking, noting the efficiency at the same time. The best lamps will bear from twice to two and a half times their normal E.M.F. This method will give the hardest and densest filaments the best place, as the quality of the vacuum has not time to influence the breaking point to any great extent (admitting, of course, that the vacuum is of the high kind produced by the best makers), and I think it is obvious that those filaments which will stand the greatest increase of current, should also last for the longest time; because a dense filament will not occlude so much gas as a more porous one, and, therefore, after a long run, there will not be so much gas driven off to diminish the vacuum in a lamp with a hard filament, as there will in a lamp with a more porous one.

Henry Crookes.

4, Westminster Chambers,
Victoria Street, S.W.,
January 25th, 1886.

Cables for the West Coast of Africa.

In a notice dated the 12th inst. of an extraordinary general meeting which was held on the 21st inst. by the Brazilian Submarine Telegraph Company for the purpose of getting the sanction of the shareholders to a scheme for laying a submarine telegraph line from the Island of St. Vincent to Bathurst, Sierra Leone, and the British settlements southward to the Niger, it is stated that in order to carry out the scheme a new company, viz., The African Direct Telegraph Company, Limited, has been formed, and it is intended that the Brazilian Submarine Company shall provide one-third of the capital required, *i.e.*, £75,000.

At the meeting it was distinctly stated by the managing director of the Brazilian Submarine Company that their company, the Brazilian, had the exclusive right of landing cables at St. Vincent for 40 years.

Well, sir, I find it impossible to reconcile the circular and the statements of the chairman and the managing director of the Brazilian Submarine Company with a paragraph which was inserted in your journal a few months ago, to the effect that the India Rubber, Gutta Percha and Telegraph Company were about to lay a cable for the West African Telegraph Company for the purpose of uniting the Cape Verde Islands with various points along the West Coast of Africa, and on to the Spanish National Submarine Telegraph Company's system at St. Louis, Senegal, under concessions granted by the Portuguese and French Governments; and in the second paragraph which also appeared in your journal, it was stated that the steamer *Silvertown* left Greenhithe on October the 10th to lay the said cable, and that Captain E. Vasconcellas accompanied the expedition as representing the Portuguese Government.

Is it therefore possible that the Portuguese Government has given the Brazilian Submarine Company the *exclusive* right of landing cables at St. Vincent for 40 years, and also granted a concession to the West Coast of Africa Telegraph Company to do likewise?

It is rather remarkable that no mention whatever was made either in the circular convening the Brazilian Company's meeting, or by the chairman of the meeting, of the cable which has already been laid between St. Vincent and Bathurst for the West African Telegraph Company. The chairman, however, admitted, when questioned on the subject, that the new company will purchase this cable. One, then, may naturally ask why this important information was omitted from the circular and not vouchsafed by the chairman at the meeting.

Another difficult point to comprehend is why, if the scheme is to be such a good thing for the Brazilian Company, that company allowed other companies, viz., the Eastern Telegraph Company and the Telegraph Construction Company to share two-thirds of the sweets. The Eastern Company have no interest nearer than Lisbon, and the Construction Company no direct interest, so far as I know, in the cables already laid.

It seems to me that the Brazilian Submarine Telegraph Company has, notwithstanding their exclusive right to land cables at St. Vincent, permitted the West African Telegraph Company to lay a cable from St. Vincent to Bathurst, and then formed another company, viz., the African Direct Company, in order that they may purchase the cable, the other three companies herein named finding the capital for that purpose; thus it will be observed that five companies are involved in this cable scheme for the West Coast of Africa, viz., the West African Telegraph Company, the African Direct Telegraph Company, the Eastern Company, the Telegraph Maintenance and Construction Company, and the Brazilian Submarine Telegraph Company, the last four of which are represented as near as possible by the same directors.

It is requisite, I think, that the shareholders in the companies concerned should know the facts in order that they may be able to discuss them at the next general meeting.

I beg to inclose my card, and subscribe myself,

A Brazilian Submarine Telegraph Shareholder.

Dynamos and Domestic Electric Lighting.

Sir David Salomons has written to you an interesting but I think somewhat misleading letter on the above subject, and as you have referred to it as worthy of the close attention of your readers, I trust you will permit me to point out to them some facts which might otherwise have escaped their notice. In the first place the thanks of all dynamo makers, as well as users, are due to Sir David for the clear way in which he has shown that much trouble and annoyance can be avoided by ordering dynamos of ample size for their work; but I think he goes rather too far in recommending such a gigantic dynamo as that he describes as a suitable size for his work. Sir David, as is well known, has a splendid installation of electric light machinery. He has several dynamos made by various makers, and as he has aimed at possessing the most perfect specimens of each class, he has from time to time exchanged his machines for those of later and more improved patterns. Sir David's requirements apparently are from 100 to 120 amp. at 130 v., at the terminals of the machine, which must be shunt wound. The unsatisfactory results he mentions as obtained from the dynamo he first got from us, is simply due to the fact that he was using only the shunt coils of a compound wound machine, originally designed to give 100 v. only, at the terminals, at its normal speed. In addition to this, the bearings heated on account of the failure of a new method of lubrication first tried by us on this machine, and which we have since discontinued. All Sir

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David's remarks, therefore, as to the heating of bearings, &c., are somewhat beside the mark. We have now arranged for the exchange of this machine for a slower speed one, properly designed for the work, and we shall be much surprised to hear that it is in any respect inferior to the Elwell-Parker machine described, although it is only about half the size and weight.

Messrs. Elwell-Parker's dynamo, weighing 3 tons 6 cwt., has been more particularly described in a communication addressed to one of your contemporaries. Its full load appears to be 182 ampères. As Sir David works it at an output of 100 amps., this was little more than half its output. This fully accounts for the favourable results as to cool and easy running, fixed position of lead of the brushes and high electrical efficiency; but with due deference to Sir David, we must submit that 100 amps. and 130 v., is a ridiculously small output for such a large, heavy, and consequently costly dynamo. We, ourselves, make one which weighs 3 tons only, and when worked at the same speed, gives 480 amps. by 130 v.; therefore, when half loaded, and therefore worked on equal conditions with Messrs. Elwell-Parker's, it gives rather more than double the output, and, we may be permitted to believe, with at least equal results as to economy and satisfactory running.

All correspondence seeking to claim pre-eminence for the goods of any one maker, is of necessity wearisome to your readers. We are sure that there are several other makers of dynamos who can honestly claim for their machines highly satisfactory results, but in the absence of competitive trials, the public must remain, to a certain extent, in the dark. Our principal object in writing to you is to show the great desirability of such competitive trials. Those carried on for several years by the Royal Agricultural Society, produced the happiest effects in improving the portable steam-engine, and I, for one, have always looked forward to the day when some public body, such as the Society of Arts, would be spirited enough to initiate a series of such competitive trials. Those carried out by the Franklin Institute in America, can, with some modifications, serve as a model for our guidance.

As a firm, we consider the question of competitive trials to be of such importance, that we should be prepared to contribute £50 towards the expense of carrying them out.

I have more to add on this important matter of competitive trials, but as my letter has already reached an inconvenient length, with your permission I will reserve my further remarks for another week.

R. E. Crompton.

London, *January 26th*, 1886.

Efficiency per Pound of Copper.

I have maintained, on several occasions, that one of the most hopeful signs of the times, bearing upon the future of electrical engineering, is the great interest which many gentlemen of means and position are taking in the practical application of the science; an interest which has led them not only to give their time and money, as to a hobby, but to acquire a practical acquaintance with the working of electrical apparatus that many electrical engineers would do well to emulate.

I am pleased, therefore, to find Sir David Salomons setting his face against the parrot-like phrases that are so common. I think, however, he is hardly just in supposing that all dynamo manufacturers are striving after the false economy he indicates.

So far as I remember, Mr. Heinrichs was the first to introduce the expression, "output per pound of copper," in order to prove the superiority of his own dynamo. It has been used very recently by Mr. Kapp, in his paper which was read before the Institute of Civil Engineers, to indicate the advantages of one particular form of electro-magnet over others. But, so far as I understand the matter, no dynamo manufacturer, who has a proper knowledge of his business, is striving to reduce the weight of copper *per se.*, in any given machine. What dynamo makers are striving after is to reduce *the proportion* of copper to iron in a dynamo of a given output.

Iron is cheaper than copper, and, moreover, for almost any section of iron, the machinery required is not appreciably increased by a small addition to the size.

As, especially in large machines, it is evident that the replacement of a shell of copper by a shell of iron of the same dimensions materially lessens the cost of the machine; the economy so obtained is perfectly legitimate, provided that in attaining this economy you do not sacrifice something which is of greater value.

To decrease the weight of copper, simply to cheapen production, without putting anything else in its place, would be as foolish, as Sir David has rightly pointed out, as to decrease the strength of the working parts of an engine, so that it may knock itself to pieces.

On the other hand, there are parts of engines, and of every mechanical appliance, to increase whose weight beyond a certain point, is to increase inertia without appreciably adding to the working strength.

And so, in designing dynamos, it is right to increase the weight of copper *intelligently*, as, by increasing the size of the wire on the armature, or the length of the wire in the shunt coils on the field magnets, *up to a certain point*, not only is the heating less, but the efficiency of the machine is increased.

But it is equally right under given conditions, as already indicated, to substitute a certain weight of iron for a certain weight of copper, if the machine so altered will do its work as well as before.

We have heard from Mr. Charles Lever that in America they have carried this point very far, their dynamos being constructed with very much iron in field magnets, and very little wire upon them; and the reason appears to be that it requires a smaller expenditure of electrical energy to generate a given amount of magnetic energy in iron when the latter is only slightly charged, or far from its saturation point, than if it be charged up to, or nearly up to, its full power.

Under these circumstances, it is easy to see that a real economy in construction, and a gain in commercial efficiency, is obtained by the substitution of the iron for the copper.

I should like, also, to protest against the parrot-like use of the term "efficiency." The true meaning of the term I take to be the return a consumer gets for the money he expends; and it is evident that there may be many cases where it is decidedly of advantage to sacrifice the efficiency of one portion of the apparatus in order to reduce the working cost as a whole. The efficiency of the whole apparatus, beginning at the furnace of the boiler, and ending at the lamp, is what ought to be considered, not the efficiency of one part of it, unless the rest are quite insignificant. And in considering the efficiency, the important item of attendance should not be overlooked. It would be the reverse of an advantage to Sir David if the 14s. a week saved in coal was only possible by the adoption of some delicate apparatus that necessitated constant looking after, and entailed an extra charge of £1 or £1 10s. for labour.

Again, it is of very little use having a dynamo of high electrical efficiency if the commercial efficiency is low; and further, there are many cases in which it might be advantageous to sacrifice both electrical and commercial efficiency to obtain a greater output from a dynamo up to a certain point, merely on account of the saving in the interest on the plant.

I do not wish to know the price of the dynamo which has given such good results; but I should like to know its commercial efficiency; and I feel sure that if Sir David would publish the tests he has made with it they would be of great interest, and he would be conferring another favour on electrical engineers.

Sydney F. Walker.

Cardiff, *January 26th*, 1886.

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THE TELEGRAPHIC JOURNAL AND

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SELF-INDUCTION OF ELECTRICAL CONDUCTORS.

IF Professor D. E. Hughes does nothing else during his tenure of office in connection with the Society of Telegraph Engineers and Electricians, his presidential address will always remain a memorable incident in the transactions of that body. It is a masterly compilation in its very simplicity, and the author deserves the warmest thanks of the whole electrical community for the light which he has thrown upon matters which until now had been more or less obscured and but little understood.

The manufacturers of dynamo-electric machines will see their way to improvements in the form of the conductors employed, both in armatures and field-magnets, and in the methods of coiling, for if the self-induction of a current upon itself may be reduced to a mere fraction of its previous force by simply separating the contiguous portions of a current from each other, the advantages of employing ribbon conductors, or a series of ribbons, will not be overlooked.

The curious effect which the Professor has observed in mixed or alloyed conductors will, no doubt, be taken full advantage of in the construction of telegraph and telephone lines.

The "Lightning Rod Man" may now take it as an indisputable fact that a flat copper ribbon conductor, or, if of iron, a stranded rope or wide ribbon of similar conductivity to the copper, should invariably be employed; a solid rod of iron being the worst possible form for a lightning conductor. This point cannot be too strongly urged upon those in whose hands is placed the protection of buildings from lightning, for here self-induction exhibits its worst effects.

The manifold subjects upon which Professor Hughes has touched will be found fully reported in our other columns, but before closing these remarks we cannot refrain from expressing the belief that immediate improvements in our telegraphic and telephonic service will be the direct outcome of these masterly researches. The advantages of using carbon as a resistance for special purposes is fully pointed out, and, indeed, there is but little in electrotechnics upon which the Presidential Address to the Society of Telegraph Engineers and Electricians does not give some valuable information.

Further comments upon certain portions of the address may be found in "Note" form.

MACHINERY IN MINES.

ON Wednesday, the 27th ult., a paper entitled "Machinery in Mines" was read before the Society of Arts by Mr. Henry Davey, M.Inst.C.E.

That portion of the discourse in which we feel most interest is devoted to the transmission of power and ventilation in these underground workings, which extend to great distances, and cover large areas. Animal power, the lecturer states, is almost entirely superseded by machinery, and he alludes to two systems only for actuating hauling engines, viz., the compressed air and the hydraulic methods. No mention is made of what can be accomplished by means of electricity, probably because the lecturer was not aware that it had been employed in any mine. Yet at the Trafalgar Collieries, Drybrook, Gloucestershire, ventilating and pumping machinery is actuated by electricity, and eventually the haulage of coals will be effected by similar means, an electrical locomotive being now in course of construction for this purpose. Mr. Davey showed how uneconomical, mechanically speaking, is the use of compressed air, for when experimenting with a pair of air compressors working underground hauling engines, the air being compressed to 54 lbs. per square inch, the total efficiency amounted to only 14·27 per cent., but when the pressure of compression was reduced to 40 lbs. per square inch, the total efficiency rose to 24·42 per cent. The experiments were conducted under precisely similar conditions, but the low efficiency in both cases is accounted for by the fact that the hauling engine did not use the air expansively. With hydraulic apparatus, however, better results are obtained, and Mr. Davey quotes a trial made at a colliery belonging to the Société Anonyme de Charbonwages des Bouches-dû-Rhone, by M. Biver, the engineer. The total efficiency of the whole system reached 54·2 per cent., *i.e.*, the total horse-power exerted by the steam engine was 229·2, and the work actually done by the hydraulic engines 124·2 horse-power.

For ventilation, mines were dependent, until the last few years, upon a furnace placed at the bottom of an upcast shaft. That system was very wasteful and had, also, serious practical objections; collieries are now generally mechanically ventilated by means of fans, whose general total efficiency is from 40 to 50 per cent. of the power applied.

For transmission of power, at least, electricity might be advantageously substituted for the present methods, at all events in mines which are not of a fiery nature. Perhaps the proprietors of the Trafalgar Collieries might not object to give the results of their experience in the use of electrical power in mines, an experience now of some years.

The Society of Telegraph Engineers and Electricians.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George Street, on Thursday, 11th February, when a discussion on the paper of Prof. Hughes, "Self-Induction of an Electric Current in Relation to the Nature and Form of its Conductor," will take place.

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THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

WE understand that with the publication of No. 59 of the journal of this society, which has just appeared, and which concludes the volume for 1885, Professor Ayrton's editorship terminates. It may, therefore, be a convenient opportunity to consider what changes have been made in the journal during the seven and a-half years it has been under his management. In the autumn of 1878, when a new office, "The Chairmanship of the Editing Committee," was created, and when he was asked to accept it, the society was, we believe, largely in debt, owing upwards of £1,000, a large portion of which was due to its printers. The first step was, therefore, to arrange for the printing of the Journal being executed at a lower cost, but this could only be effected by the society being first freed from debt, in order that tenders for printing might be obtained from the principal London firms. Consequently a loan was subscribed among the members of the council to pay the society's debt. This being done, a contract with a new firm was accepted, at a rate which would enable the society to live within its means, and this large economy that Professor Ayrton carried out, combined with the collection by the treasurer of arrears of subscriptions, has enabled the society, not only to gradually become solvent, but to invest money from time to time as the equivalent of some of the life compositions of members which, when received in the old days, appear to have been regarded simply as yearly income, and spent for current expenses.

Glancing at the last number of the journal, we observe that it contains 32 abstracts from foreign periodicals, besides six pages of the names of other electrical articles appearing recently in the foreign periodicals, and which have not been abstracted. These are all of great value to students and readers of electrical literature, and add much to the worth of the journal. Turning now to numbers of the journal issued just before the commencement of Professor Ayrton's editorship, we do not find any abstracts at all from foreign periodicals in the proper sense of the word. All that the journal contained at that time, in addition to an account of the regular proceedings of the society, was a reprint, usually in full, of one or two articles which had already appeared in English in some other periodical. The volume for the year just ended contains 110 well-prepared abstracts; indeed, the index of the names of the abstracts is as long as the index of the actual proceedings of the society. In old days the yearly index of the Journal of the Society of Telegraph Engineers was, we remember being told, used by the Society of Librarians as a specimen of how *not* to make an index, the articles being actually indexed under the definite and the indefinite article, whereas of later years the index has been carefully compiled, many cross references being made so that each title of a paper or communication, or the reference to the remarks made by any speaker at a discussion, may be found indexed under *each* of the important words in the title. The marked difference in character between the index of the journal of to-day and of former years, is seen from the fact that, whereas the annual index for 1878, the year before Professor Ayrton became the editor, only occupied 2½ pages, the index for 1885 occupies 25 pages, and is therefore exactly ten times the length.

And this very marked improvement in the index is characteristic of the general improvement in the journal. Compared with the journals of other societies which publish their complete proceedings fully illustrated, the Journal of the Society of Telegraph Engineers and Electricians is *now* in front of that of any other society in rapidity of publication.

Cable News.—The cable steamer *Sherard Osborne* left Wellington, New Zealand, on December 7th, for Cook Straits, to repair the cable there.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

VII.

MUCH misapprehension exists on the subject of the resistance to traction on tramways, or, in other words, the tractive force necessary to move a vehicle upon the road. One is accustomed to see small cars pulled by a single horse, and larger cars by a pair of horses, and only on very serious inclines one may observe an additional animal being brought into requisition to assist in the upward propulsion; it is therefore popularly assumed that the mechanical power necessary for tramway traction is something between one and three horse-power. Indeed, engineers themselves have frequently made too little provision in the range of power on tramway locomotives. On railways the resistance to traction is about 8 to 10 lbs. per ton, but such favourable conditions never exist in the case of tramways with grooved rails; and it has been found that grooved rails, when clean, on a straight line offer a minimum frictional resistance of 15 lbs. per ton.

Tramway rails are, however, exposed to much dirt, mud, stones, and to very sharp curves, and Mr. Henry Holt has ascertained that the resistance rises sometimes to over 40 lbs. per ton. Mr. Henry Hughes* deduced from experiments a tractive resistance of about 26 lbs. per ton; often more, occasionally less. Such high resistances are readily accounted for, when it is considered that the flanges of wheels frequently take a bearing on the bottom of the grooves, or on the dirt imbedded therein, at the same time that the wheels roll on the surface of the rail; for thus the wheel rolls on two different radii simultaneously, and grinding resistance is excited. Again, whilst the wheel at one end of an axle may be running on the proper bearing surface only, the wheel at the other end may be running with the flange against the rails. Sometimes the rails are a little out of gauge. Car-drivers know the value of a clear groove. One may tell you that the car requires a horse more power to draw it over clogged rails; another will tell you that it is equivalent to some hundredweights more load, or a ton or two more, according to the clearness of his perceptions. The horse would be the best witness, if he could speak his mind, but, failing his verbal evidence, the dynamometer must be consulted. Messrs. Merryweather & Sons, from their experience with steam tramway locomotives, have come to the conclusion that an average of 30 lbs. per ton may be taken as a data for the calculation of the ordinary tractive force to be provided for.

The force required for the starting of a car is necessarily much greater than the force required to maintain a uniform speed, and experiments show that this initial pull amounts to from three to four times the tractive force on the level, or from 90 to 120 lbs. per ton.

In the case of electrically propelled cars it is easy to record the variations of the motive power on any line. An ammeter inserted in the circuit will show the slightest changes in the conditions of the road; the needle will rise and fall with every alteration of the coefficient of friction between the wheels and rails; and if such coefficient were constant and the instrument very sensitive it would show the exact difference of motive power which each passenger would occasion by entering or leaving the vehicle.

In going round a curve of 50 feet radius the resistance to traction is doubled, and even trebled, if there is sand on the rails; but when the rails are wet this resistance, due to curvature, is reduced. With a very short wheel base, or better still with radiating axles or bogies, the motion on curved rails is considerably facilitated.

On tramways in towns it is not convenient to raise the outer rail of a curve to a higher level than the inner rail; there is no safeguard against effects of the

* "Tramways," D. K. Clark.

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force tending to keep the moving mass in a straight line; it is therefore all the more desirable to provide flexible wheel bases, in order to prevent the wheel flanges from riding over the inner edge of the rail and thus leave the described path. In the case of cars pulled by horses this tendency to leave the curved rails is much lessened by virtue of the side pull caused by the animals who keep in the middle of the track.

The effect of gradients is a matter of simple calculation, and it must be provided for in designing a motor and estimating the maximum power requisite on any given line.

Given a tramcar weighing 2 tons, 40 passengers 2·5 tons, electric motor and gearing ·5 ton, what power must be provided so that the vehicle may mount an incline of 1 in 40 at the rate of six miles an hour?

The resistance to traction on the level road will be $5 \times 30 = 150$ lbs., which, pulling at the rate of 528 feet per minute, gives $\frac{528 \times 150}{33,000} = 2·4$ effective H.P.

The resistance due to gravity will be $\frac{2240}{40} = 56$ lbs. per ton, or a total downward pull of 280 lbs., which at the given speed causes an expenditure of $\frac{280 \times 528}{33,000}$ $= 4·48$ H.P. effective; therefore the total effective energy to be provided for is 6·88 H.P. upon the driving axle. To this we have to add the power lost in the mechanical transmission, and also the energy lost in the motor itself in order to arrive at the current and E.M.F. necessary to drive the motor. Taking the efficiency of the gearing at 85 per cent. and the efficiency of the motor at 75 per cent., then we require 10·8 electrical H.P. at the terminals of the electro-motor, which is equivalent to 7,949 watts. With an E.M.F. of 120 volts we should thus require 66 ampères of current when mounting an incline of 1 in 40, and only 23 ampères when running on the level road, assuming that the efficiencies are the same at different horse-powers, which, however, will not be the case if one motor only is employed.

The starting (initial) current, as already shown in our previous article, depends upon the resistance of the motor circuit. The statical pull, or in other words the attraction between the armature and the field magnet at the moment of starting depends upon the strength of the current, and in a series-wound motor this statical force is approximately proportional to the square of the current strength, therefore it may be safely assumed that a motor which is capable of propelling the car at the rate of six miles an hour on any road will also be powerful enough to start it on every part of the line provided that the magnet coils are joined in series with the armature, and provided, also, that the supply of current from the generator accords with the requirements of the motor. If the motor is shunt-wound, then the conditions are altered, as the armature alone will get the excess of current at starting whilst the field is constant. Compound winding of the motor will satisfy to a greater extent the two requirements, viz., a reasonably large statical pull at starting, and a certain constancy of speed when running with a variable load. But we hope to return to this subject of winding and the effects produced thereby at some future time; meanwhile we occupy ourselves with the consideration of the general efficiency of the various systems of electrical traction, the adaptability of one system or another to special circumstances. The system requiring separate conductors for the transmission of electric energy has its advantages and disadvantages, so has the system of secondary batteries, and as we advance in knowledge and experience so will each find its proper sphere of operation.

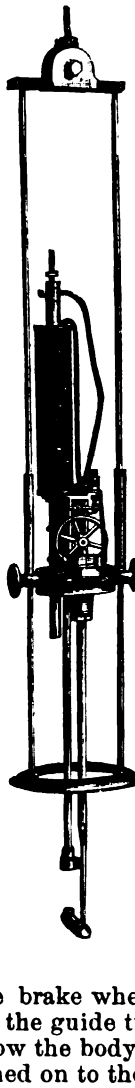
Sixpenny Telegrams.—The increase in the number of telegrams despatched in Aberdeen during the past year was 80,000. This increase, it is said, dates from the introduction of the sixpenny rate.

THE NEW STATTER ARC LAMP.

THE design of this lamp is essentially a practical one, and the aim of the inventor has been to produce a lamp which shall work well in the hands of an unskilled workman.

The regulation is effected by a solenoid, usually compound wound, and the mechanical parts used to effect the desired striking and lengthening of the arc and the feeding of the carbons are simple, strong, and few in number, and have an action easy to understand. The solenoid and its core are proportioned to respond readily to changes in the length of the arc, and, at the same time the position of the core is one of definite equilibrium and resists any attempt to make it oscillate or "pump."

In the single lamp shown in the figure, the rod carrying the upper carbon is a rack rod and it gears with a pinion, on whose arbor the deeply grooved brake wheel shown in the figure is fixed. A small steel chain, fastened to the core of the solenoid, takes



one turn round the brake wheel and is then attached to a small weight in the guide tube shown in the woodcut (projecting below the body of the lamp). Before the current is switched on to the lamp the weight rests upon the bottom of the guide tube, and the loop of the chain rests loosely in the groove of the brake wheel and leaves it free to revolve. On switching on the current the core is drawn up and the weight raised to hang upon the lower end of the chain. The wheel is now firmly "noosed" by the loop; the core is still drawn up, the wheel revolved and the rack rod wound up by its pinion. Thus the arc is formed, the core continuing to be lifted up until, by the increasing power of the shunt coils, it arrives at a point of equilibrium. To feed the carbons the core descends, at first allowing the wheel to revolve with the chain, and, afterwards, when the weight is stopped in its descent by falling upon a spring at the bottom of the guide tube, and part of its weight is in this manner taken off the chain, the wheel can slide under the chain, and so allow

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the upper rod to descend. Should, however, the speed of the engine driving the lights be suddenly increased the core will be drawn up and the rack rod again wound up, thus widening the arc, and should this increased speed be maintained the lamp will regulate as before, but with a longer arc; and in this manner the dynamo is protected by the lamps from being overheated by an excess of current being passed through the armature.

The lamp is constructed with interchangeable parts, gauges and cutters to set to gauge having been made for all the parts. By loosening a milled headed screw the rack rod may be taken out and cleaned. The case and raising and lowering arrangements are simple but handy, and designed with the view of reducing the amount of attendance.

The lamps are made in three stock sizes to burn with 7 to 10 ampères, 10 to 15 ampères, and 15 to 20 ampères.

The same mechanism is applied to a lamp having two rack rods, and these double lamps are made to burn with the same currents as the single; they burn for about 16 hours without a replenishment of carbons.

ELECTRIC LIGHTING OF STEAMSHIPS.

S.Y. *Mohican.*—This very handsome steam yacht, of 700 tons, belonging to Mr. John Clerk, of Paisley, which has just left the Clyde for a few months' cruise in the Mediterranean, was fitted throughout with the electric light to the specification and under the inspection of Principal Jamieson, College of Science and Arts, Glasgow, by Messrs. Norman & Son, of that city.

The plant consisted of a high speed Gwynne engine, driving direct an Andrews compound "Woodside" dynamo at 350 revolutions per minute, as well as 30 one horse-power E. P. S. accumulators. The whole of the circuits were wired on the "return wire" plan, and when in full operation there were 92 glow lamps, assorted power in accordance with the position they occupied in the ship at 16 or 10 C.P. respectively.

The engine and dynamo were bolted to one bedplate close to the starting platform of the main engines, and the various switches so arranged that (1) the accumulators could be charged alone; (2) the accumulators could be charged and at the same time any or all of the lamps on board lighted. In this case the accumulators formed an excellent regulator for the dynamo (just like an air vessel on a pump), and kept the lights absolutely steady. (3) One or all of the lights could be worked direct from the dynamo at pleasure without any connection with the accumulators. (4) Some 30 lamps could be worked for a few hours direct from the accumulators when it was desirable not to have steam up, such as on a Sunday night when lying in port, or to keep a certain number of lamps going should the engine or dynamo be stopped for inspection or repairs at any time.

Any of these four different ways of working the circuits could be brought into operation in less than half a minute. The behaviour of the accumulators will be watched with considerable interest, as certain precautions were taken to prevent a recurrence of the failures which have as a rule hitherto attended their use on board ship. In many instances they will be found very useful, and fully repay the extra cost of fitting them on board.

SS. *City of Bombay.*—This, the latest addition to the well-known City Line of steamers, has just been completed at Glasgow, and left for Liverpool previous to taking her turn on the company's route to and from India, &c. She has been fitted with the electric light in the engine and boiler rooms, saloon, officers' and passengers' accommodation, &c., as well as with "masthead lights" and "side lights," to the number of 112, by Messrs. J. D. F. Andrews and Company, the consulting electrician for Messrs. George Smith & Son (the managers of the City Line) being Principal Jamieson, Glasgow College of Science and Arts. The generating plant consists of two separate and independent vertical 10 I.H.P. engines, by Marshall and Sons, running at 155 revolutions, each driving by a belt a compound-wound Andrews dynamo, at about 450 revotions per minute. Each engine and dynamo is capable of easily working any of the circuits on board up to 80 lamps, and both engines and dynamos, when at work, have an easy time of it with the whole of the lights on. The mast and side lights seem to give great satisfaction, and by a simple arrangement, devised by Mr. Andrews, should one lamp break down, another automatically comes into circuit, so as to minimise the chance of these most important lights being out at any time. The wiring throughout has been done on the "single wire system," that is to say, the beams and plates of the ship have been utilised instead of return wires to the dynamo for completing the circuit. A number of letters having lately appeared in the *Nautical Magazine*, drawing the attention of ship owners and captains to the dangers that may arise from this now very popular system of wiring ships, especially to the ship's compasses, the consulting electrician and the compass adjusters, took advantage of the opportunity afforded during the adjustment of the compasses to see if there was any such effect observable on board the *City of Bombay*. The whole of the lights were simultaneously turned on and off alternately several times, and it was found that the current in the wires produced a steady permanent error of five degrees on the steering compass, and two degrees on the standard compass (Sir William Thomson's), although the nearest wire was about 12 feet from the latter compass. Of course, such an error was not permitted to remain, and the wires have been so run as to remove all chance of any compass error arising therefrom. It would in our opinion be very advisable if all ships fitted with the electric light were carefully tested in the manner stated above, for if such an error existed unknown or imperfectly known to the officers of the ship, and only appearing when certain parts of the ship was lighted at night, and on certain courses, the consequences might be very serious. Five degrees error on the night course of some of our fast speed mail boats would mean ten miles or more out of position in the morning.

BLEACHING BY ELECTRICITY.

The idea of bleaching by electricity is by no means new, indeed the early discovery of ozone generated by electrical means and the well-known powerful bleaching property of the same obviously at once suggested the possibility of an electrical process for bleaching coming into use. Several years ago the electrical bleaching of sugar was, we believe, carried on by a firm of refiners in Lambeth, the electricity for the purpose being generated by a Wilde machine. Whether the system is still in operation we are unable to say, but the fact that practically nothing has been written or published on the general subject would seem to indicate that bleaching by electricity has not been really practicable. Recently the subject has been again taken up, and this time with good prospects of success; this is owing to a discovery of M. Hermite with reference to a chemical reaction which takes place when the chlorides of the alkaline earths, and notably chloride of magnesium, are submitted to electrolysis. The chlorine in the substance under the action of the electric current has a powerful bleaching action, though, curiously enough, no waste of the substance takes place, the chloride becoming, it is stated, regenerated automatically. Thus if indigo be in solution with the chloride bath and platinum electrodes be employed, the colour becomes discharged by the action of the electric current without any sensible disengagement of chlorine. The principle has been practically applied for the bleaching of cotton goods and, we are informed, with excellent results, the fibres being far less injured by the new process than is the case under the ordinary method; this is due to the action being completely under control.

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THE SEAT OF THE ELECTROMOTIVE FORCES IN A VOLTAIC CELL.

Some Notes by Professors AYRTON and PERRY, on Dr. Lodge's Paper.*

THE value of the historical part of Dr. Lodge's paper can hardly be overrated. A fair share of credit has been given in it to all experimenters on contact forces, and his description of the different kinds of apparatus used by the various investigators is very clear and very helpful, but we certainly object to the unproved assumption running all through his paper, that there is a *primâ facie* absurdity in acknowledging a considerable difference of potentials between two metals, such as zinc and copper, in contact with one another.

He says that all the apparent differences of potential which have been measured in air are due to an air-effect; and when these same differences of potentials are obtained by measurements in gases quite different from air, he still says that they are due to an air-effect, and even that when they are obtained from measurements made in a fairly good vacuum, they are still due to air-effects. In fact, he considers that he has good reason for concluding that the existence of a large contact potential difference between metals is absurd, and he boldly puts forward the view that if measurements were made in the most perfect vacuum hitherto obtained in the laboratory, and if the results were still the same (as they probably would be) they would still be due to air-effects. Now, when it is borne in mind that all the experimental evidence is in favour of the existence of a real large contact potential difference between metals, it is quite evident that our most important duty is to examine the basis of the strong reason which has caused Dr. Lodge to discard direct experimental results, for it is this strong reason which has caused him to enter into elaborate explanations as to the attraction between gases and metals.

We will first dispose of that part of Dr. Lodge's paper which is not debatable, viz., the seat of the E.M.F. in a voltaic circuit. So far from differing from Dr. Lodge on this point, we believe that we are in agreement; and we hope to prove that this seat of the E.M.F. in a voltaic circuit has really nothing whatever to do with the potential difference between zinc and copper in contact. In fact, Dr. Lodge's paper has not got quite its proper title. The subject to which the greater part of his paper is devoted is a debatable one, but it is quite a different subject from that of the seat of the E.M.F. in a voltaic cell. In considering this latter subject we shall, for brevity's sake, regard the small Peltier effect as non-existent. Formerly, any cause of flow of electricity was called an E.M.F., and hence in stating Ohm's law, E.M.F. and potential difference were used indifferently. But when we adopt, as everybody does nowadays, the exact definition of Clerk Maxwell, we must be more careful; and when we adopt the much more guarded definition of E.M.F. of Dr. Lodge, we must be particularly careful. This definition of Dr. Lodge is given in two quotations from Clerk Maxwell; and the definition is not merely the definition of E.M.F., but is the definition of the seat of the E.M.F. *The seat of the E.M.F. in any circuit is the place at which the circuit receives or gives up energy as distinct from heat due to resistance, and the amount of the E.M.F. is measured as the amount of energy which enters the circuit per unit of electricity passing that place.* Now it is not possible with such a definition of E.M.F. as this, to give any answer to Dr. Lodge's question different from the one he has himself given. The seat of the E.M.F. is practically defined to be the place where the chemical action goes on. It follows, therefore, that the place where the chemical action goes on is the seat of the E.M.F. The answer is given in the definition, and the definition is merely a partial statement of Sir William Thomson's result—that the E.M.F. of a voltaic circuit can be calculated from the chemical action going on.

The important subject, however, taken up in Dr. Lodge's paper is, as we have already stated, quite a different one. He finds strong reasons for believing that there cannot be a considerable difference of potential between zinc and copper in contact. In fact, a large difference of potential is to him logically absurd, and he devotes the paper to speculations as to how experiments could have misled Sir William Thomson and others into believing such an absurdity. The absurdity is so obvious to Dr. Lodge, that it might have struck him, perhaps, that Sir William Thomson might also have seen it. However, as Dr. Lodge has the opinions of Clerk Maxwell and many others on his side, the question is a fair subject for debate, and we shall endeavour to show that our notions on the subject do not lead to any absurdity. With his definition of E.M.F. we have never stated that there is such an E.M.F. due to contact between zinc and copper. We deny that there is such contact E.M.F., but we do say there is contact difference of potential. We do not say that what has been measured may not be to some, even to a large extent, due to air effect; indeed, in our third paper on the Contact Theory of Voltaic Action, in Part I. of the Phil. Trans. for 1880, we drew especial attention to the possibility of air effects, and we showed, exactly as Dr. Lodge now shows, that our measurements gave no indication as to whether there is or is not an air effect. But we contend that no such air effect has ever been observed, and until it is observed we cannot admit that there is strong reason for believing in its existence, especially since we shall prove that all the phenomena of contact action can be rigorously explained without the necessity of resorting to any air action.

Dr. Lodge says that if electricity rises in potential from copper to zinc, there must be a supply of energy from some outside source at the place of contact. We ask him why he should make such an assumption? Putting on one side the question as to what is exactly meant by electricity rising in potential at a point, or by the potential inside a wire through which a current is flowing, we are willing for the sake of his argument to assume that in taking a unit of electricity from a point in a section of the wire to the outside and from that through the dielectric, and from that into the wire to a point in another section, the work that must be done is the same for any points in the sections as Dr. Lodge assumes, and to take that work as the measure of the difference of potential between these two sections; and still we ask him why we must assume that, when electricity rises in potential suddenly at a place in a circuit, energy must come in from the outside to enable the electricity to rise in potential? Suppose we grant that electricity gains in potential energy in flowing from copper to zinc, do we know so much of an electric current as to assert that when the electricity gains potential energy it does not lose an equivalent quantity of some other kind of energy? Why may we not assume, for example, that electricity loses tension energy in passing from copper to zinc, so that if it gains potential energy it loses tension energy. From that point of view, part of the function of the liquid in the cell would be taking electricity from the zinc to the copper inside the cell, giving it tension energy, and this tension energy is converted into potential energy when the electricity passes in the outer part of the circuit from copper to zinc.

But, indeed, there is no need to assume the existence of a tension energy. Why should we assume that work must be done by outside agents at a place in raising electricity from potential A to potential B? By definition work will be done if we take electricity through the dielectric from A to B, but it does not follow that an outside source must do work in carrying electricity from A to B through the wire itself. We know so little of what is really meant by the electric current, and the mechanical analogies which have been put forward from time to time are so imperfect, not even excluding the beautiful form that Prof. Poynting

* *Philosophical Magazine.*

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has given to Clerk Maxwell's analogy, that we like to fall back upon the oldest and simplest one, which is that, when electricity is flowing in a wire, at one end it is being continually thrust in, and at the other end it is in consequence continually being thrust out, just for the same reason that electricity tries to come to the outside of bodies—repulsion of electricity by electricity. Hence in the case of a copper wire one end of which is joined to the copper plate of a battery and the other to the zinc plate, electricity is being pushed into the copper wire at the end where it is connected with the copper plate, and at the other end is pushed out of the wire into the zinc plate. If at the zinc end, electricity can only get away by rising in potential, then it rises in potential, but the energy, which there becomes potential-energy, comes from the battery, and it is not necessary to get a supply of energy from any outside source.

Of course this is only an analogy, but when we speak of electricity flowing in a wire, we are using an analogy which is derived from electrostatic and hydraulic phenomena to explain a phenomenon of an electro-kinetic kind. The idea of a tension energy in electricity as distinct from a potential energy may be objected to as being new and unnecessary, but in spite of our very exact knowledge of mechanics we have the same sort of difficulty in many mechanical arrangements unless we assume the existence of a tension energy. For example, suppose you have a winding engine and a long endless inextensible rope passing over pulleys, horizontal in places, vertical in places, and coming back to the engine again, and at one place there is a weight being lifted. Now work is being done on that weight in lifting it. But energy does not come from the outside into the circuit there; it comes from the winding engine; it comes somehow through the rope. Energy disappears at the winding engine and appears as work done in the weight being lifted. In what form is it before it is converted into potential energy? The energy is conveyed. In what form is it when it is in the rope? We really do not know, or, rather, we have not given a name to it. But if we must give a name to it, it is tension energy. We know that there is a difference in the tension of the rope above and below the weight which is being lifted. Difficulties of this kind are really due to the fact that the notion of conveyance of energy from one point to another has not yet been co-ordinated with the ordinary exact definition of energy. The energy which we usually speak of as being possessed by a portion of matter, or as existing at a particular place, is really possessed by a much larger system.

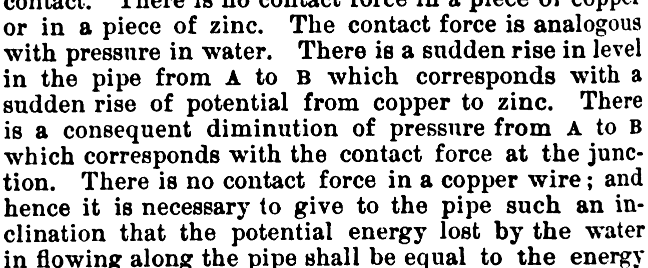
The analogy, however, which Dr. Lodge has used for showing, as he considers, the absurdity of our position, is the hydraulic one, but even with the analogy, when properly interpreted, no such absurdity is found to exist. In fact the explanation mentioned by Dr. Lodge in his paper as having come through one of us from Sir William Thomson, but which must really be regarded as having come from ourselves, as we think that Sir William has probably his own distinct method of looking at the matter, has been misapprehended by Dr. Lodge.

Suppose we have a circuit of pipes, G, A, B, D, D′, E′, E, G, whose development is shown in the figure, the two ends of the figure, G and G, being the same point in the real circuit; the pipes to be of uniform section, and to rise suddenly in level from A to B and from D to D′, and to fall from E′ to E, and there being a uniform rate of fall from B to D, D′ to E′, and from E through G to A. H, I may be any datum-level. Let us suppose that there is a continuously-acting pump in the part D′, E′, causing incompressible fluid, such as water, filling the pipes to flow continuously. Mechanical energy is given to the pump from some outside source, and the energy reappears at various places in the circuit. Thus, for example, between A and B the water rises in level. A pound of water at B has more energy than a pound of water at A, and its increase of energy is h foot-pounds, if the difference of level is h feet between B and A. It has really gained energy. What has it lost? Pressure, certainly; but pressure is not a form of energy. We know that in a steady frictionless stream

$$\frac{v^2}{2g} + 2{\cdot}3\,p + h$$

remains constant, if v is the velocity in feet per second, and p the pressure in pounds per square inch, and h height in feet above datum level. As $\frac{v^2}{2g}$ is the kinetic energy of a pound of water in foot pounds, and h is its potential energy, one is tempted to call $2{\cdot}3\,p$ also a form of energy—pressure energy; but we have just as much, and no more, right to call it so, than to speak, as we did, of tension energy in electricity. We can see that pressure conditions are not in themselves a source of energy, by imagining incompressible fluid, like water, filling a closed vessel at great pressure, and then imagining an orifice to be made, when, of course, the water is no longer subjected to great pressure. But $2{\cdot}3\,p$ enters into the expression and is familiarly spoken of as a form of energy when the stream is *steady*—when there is a continuously-acting pump somewhere in the circuit. In fact, then, we see that when a pound of water rises in level from A to B it receives h foot-pounds of energy if h is the difference in level, and it receives no energy from an outside source at A, B; energy disappears in the pump, and work is done between A and B. Now, just as difference of potential in electrical things is measured as the work which must be done, on unit of electricity, in taking it from one point, A, to another, B, *through the dielectric*, so the difference of level between A and B represents the work done on a pound of water in taking it from A to B *through the air*. And just as the water is being raised from D to D′ gains energy *without any work being done on it from an outside source*, so we may consider that electricity in passing from copper to zinc may gain potential energy *without there being any external source of energy at the junction.*

The preceding is even more than an analogy. There is a tendency for electricity to leave copper and enter zinc at the junction, which we are now prevented from calling the E.M.F. of contact, but which we may call contact force. It is measured as the difference of potential established between two metals which are in contact. There is no contact force in a piece of copper or in a piece of zinc. The contact force is analogous with pressure in water. There is a sudden rise in level in the pipe from A to B which corresponds with a sudden rise of potential from copper to zinc. There is a consequent diminution of pressure from A to B which corresponds with the contact force at the junction. There is no contact force in a copper wire; and hence it is necessary to give to the pipe such an inclination that the potential energy lost by the water in flowing along the pipe shall be equal to the energy given out in friction. In the voltaic circuit, similarly, the fall of potential energy is known to be equal to the heat produced in overcoming resistance.



The analogy may be carried still further, for we may obtain the representation of thermoelectric effects. Suppose the water to be slightly compressible, then maintaining any vertical parts of the pipe at different constant temperatures will help or oppose the action of the pump in the circuit. Thus, not using a pump, let there be an endless pipe, rising suddenly from A to B, horizontal from B to C, falling suddenly from C to D, and horizontal from D to A. Imagine this filled with

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a slightly compressible fluid, and that the limb, C, D, is permanently kept at a higher temperature than A, B, there will be a steady flow maintained in the direction A, D, C, B, A. If the limb, A, B, is the higher in temperature, the flow will be in the direction A, B, C, D, A. Strictly speaking, we ought to consider the fluid in the endless tube to be one which changes the law connecting its density and temperature at a critical point, like water at 4° C.

To be quite correct, let what we have called "tension" in a metal, *a*, at the absolute temperature, *t*, be denoted by ${}_tP_a$; and the increase of potential from *a* to a metal, *b*, as measured inductively, by ${}_tV_{ab}$, then the E.M.F. of a thermo-electric circuit of two metals, *a* and *b*, whose junctions are at temperatures t_1 and t_2, is

$$E = {}_{t_2}V_{ab} - {}_{t_1}V_{ab}.$$

The Peltier effect at a junction is

$${}_t\Pi_{ab} = {}_tP_b - {}_tP_a - {}_tV_{ab},$$

where

$${}_tV_{ab} = (k_b - k_a)\, t \left\{T_{ab} - \tfrac{1}{2} t\right\} + C_b - C_a.$$

and

$${}_tP_a = \tfrac{1}{2} k_a t^2 + C_a.$$

k_a and C_a are constants peculiar to the metal, *a*, and T_{ab} is a constant peculiar to the two metals, *a* and *b*.

Hence

$${}_t\Pi_{ab} = t \frac{d}{dt} \cdot {}_tV_{ab},$$

or the Peltier effect is proportional to the product of the absolute temperature into the rate of change of contact potential difference with temperature. Consequently, *although the amount of heat generated when a unit current is sent through a junction for a second is the measure of the coefficient of the Peltier effect, this coefficient is in no sense a measure of the contact potential difference existing at the junction.*

This really disposes of Dr. Lodge's fundamental argument—the argument, in fact, on which his whole objection to the large contact-potential difference at the junction of metals is based; for he *assumes* that in all cases where there is a considerable difference of potential at a junction, heat or cold must be developed when a current flows across that junction. He states, what is quite true and well known, that practically no heat is developed when a current flows from zinc to copper across the junction; therefore he concludes that there can be no contact-potential difference at this junction like three-quarters of a volt. But if, as we have proved, the coefficient of the Peltier effect is *not* a measure of the contact potential difference, but of the product of the absolute temperature into the rate of variation with temperature of the contact potential difference, it follows that the smallness of the Peltier effect does not require that the contact potential difference must be also small.

We have endeavoured to experiment on this rate of variation of the contact potential difference with temperature; and in the discussion on Dr. Lodge's paper before the Society of Telegraph Engineers and Electricians, we gave a number of hitherto unpublished results which we had obtained on this subject. The apparatus we employed was the same as that which Dr. Lodge described as being used by us in our former experiments on contact potential difference, and with it we measured the contact potential difference of hot and cold mercury and of hot mercury and cold iron, hot mercury and cold copper, also for hot mercury and cold platinum, in each case for various differences of temperature. The results obtained were large (amounting in the case of mercury and iron to as much as 3 volts for about 16° C. difference of temperature), and not small, as might have been expected from the preceding equation and the smallness of the coefficient of the Peltier effect. We explained, however, that the very large potential differences we obtained were probably due to *invisible* films of oxide on the surface of the warm mercury, which probably existed in spite of the fact that every effort was made to remove this oxide by distilling the mercury between every two sets of experiments; and we showed that in such cases the summation law does not hold true—that is to say, the E.M.F. of a combination is not equal to the algebraical sum of the various potential differences at the contacts, *measured inductively*, and which we have always found to be true in other cases when the experiments were conducted with as much care as was devoted to those made with hot mercury. For example we found that

Copper at 16° C., with *clean* mercury at 16° C., had a contact difference of 0·308 volt;

Mercury at 16° C., with mercury at 26° C., had a contact difference of 0·75 volt;

Mercury at 26° C., with copper at 16° C., had a contact difference of − 1·5 volt.

Therefore, if these numbers represented the true contact potential differences, a thermopile consisting of two pieces of cold copper at 16° C., dipping into two vessels of mercury, one of which was warmed up to 26° C., and which were joined together by a syphon tube containing mercury, ought to have an E.M.F. of half a volt. But, as was to be anticipated, we found experimentally that no such E.M.F. could be obtained with such a thermopile, unless there were an oxide present at the hot junction separating two of the metals, and thereby introducing a high resistance.

Contrasting these results with those given in our papers read before the Royal Society (and which prove conclusively that when a cell is formed of a number of substances, solid or liquid, at the same temperature, its E.M.F. is equal to the algebraical sum of the various contact potential differences, *measured inductively*, in air, of each of the pairs of substances in contact in the cell), we are justified in concluding that when layers of oxides or their salts are formed on the surfaces of the substances employed, as in Mr. Brown's experiments, the measured potential differences do not represent the true contact potential differences of the substances employed.

We are not disposed to think that Dr. Lodge has discovered any striking coincidence between measured chemical heats of combination and those heats as calculated on his theory. Such coincidence as he has discovered is not more wonderful than that the electropositivity of the metals should be in the order of their tendencies to combine with oxygen; there can be no doubt that an exceedingly important advance in the sciences of chemistry and electricity will be made by the philosopher who explains this and the twenty other coincidences of a like nature which have been discovered. We are quite sure, too, he would regard the seeming coincidences which he has discovered as trivial, had he not at the beginning made up his mind that the existence of contact difference of potential was absurd, and that what we and many others have measured are due to air effects.

We are in the habit of using the expression "difference of potentials between two points" as meaning, in *Electrokinetics*, the *Electrostatic* difference of potentials between two copper wires, coming from the points. This practice is very convenient; and there can be no objection to it, so long as we do not imply that it is always the same as the *Electrostatic* difference of potentials between the points. Now it seems to us that Dr. Lodge, in following this convenient custom, has fallen into the error of imagining that what he has been in the habit of calling "difference of potential," is really the same as "*Electrostatic* difference of potential." Indeed, we believe that the root of the whole difficulty which prevented Clerk Maxwell, and which now prevents Dr. Lodge, from seeing the position of the contact theorists, lies in their defining potential in a new way not recognised in electrostatics. Clerk Maxwell's electro-magnetic theory is so perfect in itself that no one thinks of attacking it; and we very much wish that we had the leisure to show, what we feel might probably be shown, that throughout his mathematical work, when he speaks of difference of potentials it is not necessary to assume that he speaks of electrostatic difference of potential.

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Dr. Lodge, in his reply to remarks made during the discussion at the Society of Telegraph Engineers and Electricians, was kind enough to mention the fact that we had drawn Prof. Poynting's equipotential surfaces and lines of flow of energy as they must be drawn in practice, most of them lying like successive sleeves in an infinitely shallow space round all the conductors in a voltaic circuit, if we are to follow Maxwell in assuming a considerable difference of potential between air and metals. As Dr. Lodge has stated, we have also drawn these surfaces and flow-of-energy lines on our own assumption of no air effect and considerable contact differences of potential. Dr. Lodge did not, however, refer to the very much more interesting curves which we have drawn as the energy lines from a primary voltaic or thermo-electric circuit whose current is altering just in such a way as to keep the current in a secondary circuit constant. Suppose it is the E.M.F. of the primary which is altering, it is very interesting to see how the lines of flow of energy sweep over the primary circuit, their parts which cut the secondary remaining unaltered. But now, suppose the total E.M.F. of the primary to be less than 1 volt, and imagine that Prof. C. Maxwell and Prof. Poynting and Dr. Lodge were right in their idea of a considerable difference of potential between air and metals, it will be found that no line of flow of energy can connect the primary and secondary circuits, since all the equipotential surfaces of the primary will lie infinitely close to the conductors of which it is composed, and yet it cannot be doubted that the secondary circuit receives energy from the primary.

For the purpose of evading all difficulties which might be due to our taking different numbers to represent possible contact differences between the parts of a voltaic circuit and air, let us test Prof. Poynting's deduction from Maxwell's theory in another way. Assume that there is a voltaic circuit completely enclosed in a hermetically-sealed metallic case; and let us suppose that, just before sealing up, we set up differences of potentials of many thousands of volts between the voltaic circuit and its case, and that it is in our power at any instant to cause any regular change of current in the voltaic circuit by means of mechanism enclosed by the case. Now let there be, outside the case, a secondary circuit, and let the primary enclosed circuit have its current diminished at such a rate that a constant current is maintained for a short length of time in the secondary by induction. We know quite well that such an inductive effect might take place, and that the energy of the secondary circuit must somehow come from the primary; and it must be remembered that it need not have been by a diminution of the primary current, but an increase of the primary current, that this induction takes place. We cannot see how it is possible that Prof. Poynting's electro-potential surfaces can proceed from the primary so as to pass through the secondary circuit; we can, however, imagine that, instead of equipotential surfaces, such as we speak of in electrostatics, if we speak of a series of surfaces cutting the lines of electrical displacement at right angles, then an explanation becomes quite possible. In fact, it seems to us that if Prof. Poynting's views are logically deducible from Maxwell's theory, it is necessary to assume that Maxwell's differences of potential are essentially different from electrostatic difference of potentials.

September 3rd, 1885.

Note added December 14th, 1885.

Since these notes of our remarks made in the discussion on Dr. Lodge's paper were sent to the Editors at the beginning of September, a paper on Contact Electricity has been read by Dr. Hopkinson before the British Association, and has appeared in the *Philosophical Magazine.* We are glad to see that Dr. Hopkinson, who has entered so fully into the energy equations, not only for Sir William Thomson's view, but also for that of Prof. Maxwell and Dr. Lodge, has come to the same conclusions as ourselves.

We leave our formulæ in these notes as they were written in April last, following Prof. Maxwell's lettering; but for the sake of those who may have studied that part of Dr. Hopkinson's paper which refers to Sir William Thomson's theory, it is well to state that

he uses	$f(t)$	where	we use	$_tV_{ab}$,
„	$F(t)$	„	„	$_t\Pi_{ab}$,
„	$\phi(t)$	„	„	$t\,k_a$,
„	$\psi(t)$	„	„	$t\,k_b$.

REVIEW.

Situation of the Telephonic Systems.—Published by the Bulletin International de l'Electricité. Paris: Schiller.

This pamphlet will be exceedingly useful to all persons interested in the development of the telephone. An introduction notes the general position of affairs and brings to light the curious fact that in the two European countries where interurban communication is most extended and most successful, *i.e.*, England and Germany, the results are similar though the systems are quite different. In Germany telephonic working is kept strictly in the hands of the State, whilst in England it is entirely free. A series of tables shows the companies active in each country, the towns supplied, their population, the number of subscribers, the price of subscription, and where interurban communication is established, its extent. We find that, as far as Europe is concerned, Germany has the greatest number of systems (91) 70 of which have been established since 1883, and 14,733 subscribers. Great Britain follows with 89 systems, but has 15,114 subscribers. The prices of subscription vary greatly. Thus in the United States alone they range from 300 francs yearly at Providence to 750 at New York. In England the lowest charge, 200 francs, is at Accrington, and the highest, 500 francs, prevails at London, Manchester, Liverpool, Widnes and Glasgow. In Germany the scale is much more moderate, ranging from 62 to 185 francs.

LEGAL.

The Pall Mall Electric Association.—In the Chancery Division of the High Court of Justice (before Mr. Justice Chitty) on Saturday, the petition of Mr. G. J. Baker for the winding up of the company came on for hearing. Mr. Ince, Q.C., who appeared in support of the petition, said he did not propose then to ask for a winding up order, but only for some directions as to how the matter should be treated. The petitioner was a creditor, and the company, which was formed for the purpose of supplying electrical medical appliances, would, unless something was done to stop it, be dissolved in a few days in accordance with resolutions which had been passed to that effect. The claim was in respect of commission on the business carried on by the company, which was due to the petitioner under an agreement, and there would be questions raised as to what the business of the company was, and the amount upon which commission was payable. If it had not been that the company was about to dissolve, Mr. Baker would have brought an action in the ordinary way. If, however, his friend Mr. Romer, who appeared on the other side, would arrange matters so as to make it possible to adopt that course, his client would go on with his action, and consent to the petition standing over. Mr. Romer: In the agreement under which your client claims there is an arbitration clause. Why should it not be referred? Mr. Justice Chitty: Let the petition stand over for a week, and see if you cannot agree to refer the matter; and if so, take an order accordingly. Mr. Ince consented.

British Electric Light Company, Limited.—A petition for the winding up of this company was on Saturday ordered by Mr. Justice Pearson to stand over for a fortnight in order that some arrangement might be made for the disposal of the company. An application was made before Mr. Justice Chitty on the previous

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day on behalf of the debenture holders for the appointment of a receiver, and his Lordship appointed the secretary of the company.

Otto *v.* Sterne. (Before Mr. Justice Pearson, Monday.)—This was one of the actions brought to restrain the infringement of Dr. Otto's patent for the silent gas engine. The defendants are Messrs. L. Sterne & Co., who are engineers carrying on business in London and at Glasgow. By consent judgment was now given for a perpetual injunction restraining the defendants from infringing the patent, no costs being given, and the defendants agreeing to take a license to use the patent.

The Grosvenor Gallery Lighting.—Mr. Charles Dixon Aria, of New Bond Street, appeared at Marlborough Street to an adjourned summons taken out at the instance of Sir Coutts Lindsay & Co., Limited, charging him with having on the 7th of July, 1885, in a certain affidavit filed in an action between Smethurst & Co. and Sir Coutts Lindsay & Co. in the High Court of Justice, committed wilful and corrupt perjury. The charge, which was before Mr. Newton in August last, arose out of an application to restrain the company, as proprietors of the Grosvenor Gallery, adjoining Mr. Aria's premises (Smethurst & Co.) from placing and erecting certain machinery therein for the purpose of electric lighting. It was alleged that the defendant, in his affidavit, falsely swore to the depth of his firm's cellars, and maintained that they were affected by the vibration of the machinery. Mr. Aria's statement was partly amended after the summons was taken out, and the question to be considered was, whether there was wilful perjury or not? The defence was, that the statements in the affidavit were made erroneously, and did not in any way affect the decision of Mr. Justice Chitty, when he granted an injunction, the matters they referred to not having been mentioned to the learned Judge when the application was made. On the case being called on, it was stated that the action was still pending, and, after legal arguments, Mr. Newton dismissed the summons.

NOTES.

Electric Lighting for Temporary Exhibitions.—At the recent Food and Cookery Exhibition held at the Royal Aquarium, the stalls in the exhibition were lighted by means of incandescent electric lamps. In many instances the material of the stalls was of a very inflammable nature, being composed of painted canvas, and containing lace curtains and ornamental paper, in which the employment of any other than the electric light was inadmissible. In the table decoration competition it played an important part; the effect of the lamps placed among the fruit and flowers, and also on the trees in the apartments, being extremely pretty. Upwards of 150 lamps were employed, the work being carried out by Messrs. A. R. Sennett & Co.

The Electrical Power Storage Company.—This company is busily engaged in installation work, to which branch of business it has been devoting special attention. The company has recently completed an installation at Mr. J. W. Logan's, Market Harbro', of 150 60-watt lamps, supplied by a 10 H.P. Marshall engine, placed about 200 yards from the house. It is now carrying out an installation at the Prudential Assurance Company's offices, where 1,500 lamps will be fixed when completed; also at Mr. Goddard's, Leicester; the Bank of New South Wales, Broad Street; Mr. W. Griggs' and Mr. F. D. Bumsted's. The company has recently undertaken the completion and working of the installation at Lloyds, where upwards of 500 lamps will be fixed when complete.

The Electric Light in the Royal Navy.—The *Alacrity* is being fitted at Portsmouth with the electric light, and will be ready for sea on May 1st next, when she is to be commissioned by Commander Le Strange, for service in the Mediterranean.

The Thomson-Houston Electric Lighting System.—The large factory of the Thomson-Houston Electric Company, at Lynn, Mass., is to be doubled in size and capacity, the immense business of the company requiring this addition.

A Chance for the Electric Light.—At a meeting of the Town Council of High Wycombe, a letter was received from the secretary to the gas company, stating that the directors, after carefully considering the charge for street lamps, were unable to reduce the same on the present terms, but that they were willing to supply gas to the street lamps at 3s. 9d. per 1,000 cubic feet, the sanitary authority, at their cost, doing the lighting, extinguishing, cleaning, and repairs. Several members observed that these terms would be no improvement on the present contract, and notices were handed in by Councillors Goodearl and Johnson, the former to move at the next meeting "That steps be taken to light the town by some other means than by gas," and the latter relating to the hours of burning gas in the street lamps.

Armington and Sims Engines.—The Armington and Sims Engine Company, of Providence, R.I., is said to be doing a heavy business, having for some time past run their works night and day. Fifty-one engines were shipped in November and December, and about sixty orders remained to be filled. The engine is meeting with great success in the electric lighting field.

Electric Lighting of Ingestre Hall.—The Earl of Shrewsbury has had Ingestre Hall lighted up with the electric light, which is supplied to every room in the house, and the stables and offices are also lighted. There are two 25 horse-power engines employed.

The Ball Electric Lighting System.—An installation of electric lighting on the Ball system has just been made in a large oyster house in Chicago, and much satisfaction is felt with its working in this particular case and in others where the much-condemned so-called "Unipolar" dynamo is used.

Electric Lighting of a New York Wholesale House.—The large wholesale house of H. B. Claflin & Co., occupying one-half the city block bounded by Worth, Thomas, and Church Streets, and West Broadway, New York, now possesses one of the most extensive and noteworthy private installations of arc and incandescent lighting in the country. The plant operated was furnished by the Mather Electric Company, of Hartford, Conn. All of the upper floors of this immense establishment are lighted by a total of 105 arc lamps, whilst the private offices, book-keeping department, the receiving and delivery departments, and a labyrinth of subways, are brilliantly lighted by 500 incandescent lamps, ingeniously arranged to secure an admirably even distribution of the light. The power room is situated in the lower portion of the building, and is about 40 feet long by 20 feet in width; it is brightly lighted by 16 candle-power lamps. In the middle, on either side, are planted two fine Buckeye self-contained engines, 13 by 16 inches cylinders, 75 horse-power nominal. There are, at one end of the room, one 500-light Mather incandescent and two 25-arc light machines, and at the other end one 30 and one 25 arc-light dynamos. The station was established on the 5th November last, and has run without a hitch or a stop since that date.

Electric Lighting of the Albany Capitol.—"When all the electric lighting appliances are completed for the Albany Capitol," said Superintendent F. P. Little, of the United States Electric Light Company, "the building will be the most extensively and brilliantly-lighted in the world. The capitol will take 4,000 incandescent lights, representing 64,000 candle-power; 100 arc lamps of 2,000 candle-power each, and 25 lamps each on the senate and west-end staircases, of 125 candle-power each. To run the incandescent lights will take seven dynamos, aggregating 600 horse-power, and one 20 and one 50 horse-power dynamos to run the arc lights. No isolated plant exists in the world so large as the one the capitol will contain, when the building is finished."

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The Dalton Electric Lighting.—The Electric Lighting Committee of the Dalton Local Board has reported as follows:—"In continuation of their report, submitted to the Board in November last, the committee have to state that, having considered the report of the engineers (Messrs. Badger and Sons, of Rotherham), upon the condition of the engine and boiler originally proposed in his specification to be furnished by Mr. Menzies for electric lighting purposes, which the engineers found in many respects defective, and to require considerable repairs, the committee could not accept the same. The above recommendation is made to the Board for adoption, subject to the Local Government Board's approval of the electrical lighting scheme. That the offer of the Askam and Mouzell Iron Company to sell to the Board 200 yards of land on the east side of Duke Street be accepted, and that the clerk proceed to obtain title thereof and conveyance to the Board for production to the Board of Trade, in order to complete and give effect to the license. That the former resolutions of the Board in reference to the application for loan be varied as follows, viz.:—That application be now made to the Local Government Board for sanction to borrow the sum of £1,600 for electric lighting purposes, the repayment whereof shall extend over a period of 20 years." Mr. Hamer moved the adoption of the report. He said Prof. Jamieson's report showed that the place was well adapted for the light; it also suggested that they should have an additional dynamo in case of accident. The Board would get 120 lamps, with double the illuminating power, at the same price that they were paying for 60 lamps. They could with the proposed plant extend the number of lamps to 240 without extra men or labour. The total cost, including engine house, &c., would be £1,542. It had been thought wise to have a report as to the second-hand engine, and it had been unfavourably reported upon, and tenders were obtained for another engine and boiler. They proposed to apply for power to borrow £1,600, although he did not think the whole of this sum would be expended. At the same time the committee thought it advisable to apply for £1,600. The report was adopted.

Electric Lighting and Steam Boilers.—The *Contract Journal*, in a leading article, says:—Installations require steam power, and this means steam boilers. The use of steam boilers may or may not be attended with danger. The materials, the tools, and the practical knowledge requisite for the manufacture of boilers of such extraordinary strength as to almost render an explosion impossible are all at hand. The difficulty is to persuade the general public to credit this, and there is little doubt that fear of an explosion does much to deter those who would otherwise have installations from doing so. To promote the advancement and general adoption of electric lighting, two things must be done as regards the steam power. One is to take the most effectual precautions against a disaster taking place, and the other is to inspire the public with confidence.

Proposed Adoption of the Electric Light at Hanley.—The Hanley Town Council has appointed a sub-committee to consider the desirableness and the cost of lighting the public buildings, and eventually the streets of the borough, by electricity.

The West London Electric Lighting.—The Vestry Board of St. James's, Westminster, has decided to request the Board of Trade to oppose the Bill of the West London Electric Lighting Company, and will itself oppose the draft provisional order as a whole.

Domestic Electric Lighting.—The residence of Col. Miles, M.P., Burtonhill, Malmesbury, is to be lighted by the electric light; about 150 lamps will be employed. The work has been entrusted to Messrs. A. R. Sennett & Co.

Large Isolated Plant.—At Two Rivers, Wis., an isolated plant covering an area of one-half by one-quarter of a mile has just been placed by the Edison Company, which furnishes illumination for mills on opposite sides of the river, one of these being supplied through an armoured cable laid in the river bed. This is a new departure, and is reported a perfect success.

The Portsmouth Telephone Exchange.—At the annual meeting of the Portsmouth Chamber of Commerce, the President (Mr. J. Bonham Carter, J.P.) in the chair, the report which was presented to the members stated that the telephone exchange opened at Portsmouth, mainly by the action taken by the Chamber, now numbered over 50 subscribers, and it was hoped it would be more used by commercial members throughout the scattered districts of the borough. To make it still more useful the council hoped to arrange with the telephone company to establish places of call in the four districts of the town. The Chairman acknowledged the liberal spirit in which they had been met by the Western Counties and South Wales Telephone Company, and expressed the opinion that with 59 subscribers as a nucleus they might expect that the exchange would increase rapidly. He hoped to see the exchange number its hundreds.

Professor Gray's Telephone.—A company with $10,000,000 capital has been formed at Chicago to work Prof. Elisha Gray's telephone patent and protect his interests in the Courts.

Telephone Wires in Edinburgh.—The Edinburgh Town Council has decided to accept the estimates of the National Telephone Company for a wire from the Exchange to the City Hospital at £15 per annum, and for a wire to the City Chambers at £10 per annum, and the estimate of Alexander Maclean & Co. for a wire from the City Hospital to the office of the Medical Office at £5 per annum.

Increased Telegraphic Facilities at Portsmouth.—Thanks principally to the efforts of Count Metaxa, a resident, an application has been made to the Treasury for the Albert Road Post Office at Southsea to be made a receiving office for telegrams, and the change will be made as soon as the necessary permission has been obtained.

A Generous Gift.—Mr. J. W. Mackay, the Silver King, has presented all the employès of the Commercial Cable Company in America and in Europe, from the general manager to the humblest messenger, with a Christmas bonus in the shape of a half month's pay, to show his appreciation of their exertions during the past year.

Telegraph Revenue.—The receipts on the telegraph service for the period between April 1st, 1885, and January 30th, 1886, amounted to £1,480,000 against £1,490,000 received from April 1st, 1884, and January 31st, 1886.

Imitation Telegrams.—The following notice has been issued by command of the late Postmaster-General: "Numerous advertisements having been issued in the form of fictitious telegrams, and many complaints having been received on the subject, the Postmaster-General thinks it right to call attention to the fact that the printing or circulation of fictitious telegram forms or envelopes, or of any document or form which is an imitation of a Post Office form, is an infringement of the sixth section of the Post Office (Protection) Act of 1884, and that any person acting in contravention of that section is liable to prosecution."

Recognition of Bravery.—Mr. H. Tomlinson, Demonstrator of Natural Philosophy at King's College, has recently been awarded the bronze medal and certificate of the Royal Humane Society for saving a young girl from drowning, at Seaford.

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Overhead Wires.—The Metropolitan Board of Works has written to the local boards of the Metropolis in reference to the breakage and fall of overhead telephone and telegraph wires during the recent snowstorm, requesting information of any damage which has been caused in their respective districts.

At the last meeting of the Strand District Board of Works the Surveyor presented a report of the different overhead wires in the district which had given way in the late snowstorm. The list was not complete, but, so far as he was aware, there were no accidents—at least, he had heard of none. Mr. Lay suggested that a list of the different overhead wires in the district should be made out from time to time with a view to ascertaining as far as possible to whom they belonged. Mr. Jones (Metropolitan Board of Works) did not think much practical good could come of this. The great thing was to prevent, as far as possible, the granting permission for overhead wires, and he thought this should be urged on the Metropolitan Board, who should be asked to disallow overhead wires in future.

Why Electricity Should be Used.—One of the main boiler-pipes of an engine on the Dublin and Lucan steam tramline exploded on Tuesday morning at Chapelizod. The tram, it seems, had just stopped when the explosion took place. James Malherin, engine-driver, and Michael Casey, the stoker, were frightfully scalded. They were subsequently driven to Madame Stevens's Hospital. There were some passengers on the tram, but none sustained any injury.

Why not Electricity?—At a recent meeting of the Blackburn Town Council it was resolved to sanction the laying of nine miles of tramways in the borough, half to be worked by horses, and the other half, consisting of a trunk line from Blackburn to Church, by steam.

New York Underground Wire Commission.—The New York *Electrical Review* understands that the New York Subway Commission has finally reached a decision in the matter of recommending an underground system after examining the claims of over one hundred applicants.

Anglo-American Brush Corporation.—The report of this company, in another column, shows an improved state of affairs as regards the preparation of the accounts, as well as in the matter of business done, and we must congratulate the directors upon having, amid many difficulties, brought the company from the exceedingly precarious position it once occupied to one of comparative safe-standing. We venture to suggest, however, that they might with advantage and justice go yet further in the direction of depreciation, especially as regards the amounts under the heads of "Patents" and "Stock," which, in our opinion, are still vastly too high. In so far we deprecate the payment of a dividend, as misleading to the shareholders. A central generating station at Manchester is mentioned in the report, but no particulars respecting it are given; our curiosity is aroused as to the nature of this central station, and we should be glad to be informed of its locality and of the amount of business done in connection with it.

The Electric Lighting Act.—At a general meeting of the Electric Lighting Act Committee recently held at the offices of the Anglo-American Brush Electric Light Corporation, Belvedere Road, Lord Thurlow in the chair, a resolution was adopted on the motion of Viscount Anson, approving the action of the Executive, and expressing satisfaction at the announcement that Lord Rayleigh had, at the request of the Executive, agreed to introduce the Bill drafted by the Committee into the House of Lords.

The Kinetic Engineering Company.—This company has opened a branch depôt and show room at 117, Queen Victoria Street, E.C.

He Found It!—An explosion of gas shortly before eight on Saturday night was caused through seeking for an escape of gas with a light on the premises of Messrs. Steinway and Co., pianoforte manufacturers, at 17, Lower Seymour Street, Portman Square. An escape was detected, and a Mr. Henry Trenchman attempted to discover the source of leakage by means of a lighted candle. The result was a loud explosion which caused great damage to the lower part of the premises, and was followed by a slight outbreak of fire, quickly subdued. Mr. Trenchman was somewhat seriously burnt about the face and hands.

Electric Communication Between Vessels at Sea.—*Science* states that an experiment in the direction of securing communication between vessels at sea by means of electricity will be made at some time during the present week in the Chesapeake Bay. A board of naval officers has been detailed to witness the trial. They will be accompanied by Professor A. Graham Bell, who has long been interested in the subject, and who has himself experimented upon it.

Electric Locomotion.—At a meeting of the Elektrotechnischen Verein, held at Berlin on the 22nd of December, 1885, Herr J. Zacharias read a paper on electric locomotion, especially with regard to tramlines, and to which we have previously alluded. The chief subject of the lecture was Mr. Reckenzaun's electric tramcar. Opening the discussion, which followed the lecture, Prof. Dr. Foerster, after having conveyed the thanks of the meeting to the lecturer for his paper, which promised a real Christmas gift for electrotechnics, asked Mr. Reckenzaun, who was present, whether he had any remarks to offer. That gentleman stated that he had nothing to add, as the lecturer had placed everything in such a clear light; but that he was prepared to answer, at the conclusion of the meeting, any criticisms or questions affecting his invention. Dr. Werner Siemens said that there was no faith generally in the durability and commercial value of accumulators for electric locomotion, &c.; that, however, Mr. Reckenzaun does not share that unbelief, and that he has apparently succeeded in the construction of a practical secondary battery. It would be a great blessing to the development of electrotechnics if those secondary batteries prove reliable. Dr. Siemens further said that there are two bold features in Mr. Reckenzaun's undertaking: Firstly, his faith in the accumulator; and, secondly, the worm gearing he employs. As regards economy, Dr. Siemens agreed with Mr. Reckenzaun, that electrical traction is more economical than animal traction; the engine consumes coals, the horses consume oats, and of the two the latter commodity is the more expensive.

Forms of Electrical Conductors.—The self-induction of a flat copper conductor Prof. Hughes finds to be far less than that of a solid of circular section during the variable period. Even with a constant current, as in the stable period, he further adds, this form of conductor, as *first shown* by Prof. George Forbes, would, from its greater radiation, convey more current with less heating than a wire or rod of the same resistance. We have, on previous occasions, stated that the work of Prof. Forbes on this subject is simply an elaboration of the prior publications of the late Robert Sabine, and to this fact we would call the attention of Prof. Hughes. In an article to the Review in January, 1883, the first, so far as we are aware, dealing with the loss occasioned by heat in electric light conductors, Mr. Sabine says:—"The best form would probably be a copper band which would present a large radiating surface."

Electric Tramway on Ryde Pier.—In accordance with a resolution passed a short time since at a general meeting of the Ryde (Isle of Wight) Pier Company, the tramway on Ryde Pier is in future to be worked by electricity, which, it is believed, will prove cheaper and more efficient than the present system, by which

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horse-power is used. A 16 horse-power Otto engine, manufactured by Messrs. Crossley and Co., with all the latest improvements, including a self-starting apparatus, is being erected at the south end of the pier, while Messrs. Siemens and Co. are engaged in fitting up a most powerful dynamo machine to supply the motive power, which can be stored on the cars themselves. The Ryde Pier Company is to be congratulated on having thus adopted the electric mode of traction in preference to the cumbersome and inelegant wire-rope system, which, on the ground of economy, found favour among a certain number of the shareholders. The increasing traffic on Ryde Pier rendered the change necessary, and it is confidently believed that the novelty of the new departure will induce many visitors to the pier to ride in the trams who otherwise would walk. The improvement was referred to at the annual dinner of the *employés* of the Ryde Pier Company, held a few days ago under the presidency of Mr. George Garnett, C.E. (a member of the board of directors), when Mr. Conner, of the Isle of Wight Railway, said that the electric tramway showed great enterprise on the part of the directors. The shareholders would have great reason to be proud of it, for it would be the first electric tramway in the country. There existed a successful toy railway at Brighton, but this would be something more, and would attract visitors from all parts of the country. The Chairman said that the fact pointed out by Mr. Conner that this was the first real electric tramway in the country was well worthy of notice. Within a month he hoped to see an electric tramway travelling up and down the pier.

[We imagine that by the "country" is meant the Isle of Wight.—EDS. ELEC. REV.]

Professor Hughes on Self-Induction of an Electric Current.—There are several points in the admirable inaugural address of Prof. Hughes, which will no doubt be commented on in the discussion which is to take place on the 11th. As regards the experiments on the self-induction in wires of various diameters, it appears to have been overlooked that, as the battery power employed was preserved constant, the change in the diameter of the wires must have reduced the total resistance of the circuit, and consequently altered the current flowing through the wires; thus *two* conditions are altered which may possibly account to some extent for the form of the diagrammatic curves obtained. We would also suggest that the fact of iron being a magnetic and copper a diamagnetic metal, would account for the peculiarity noted as regards iron and copper rope, the iron strand being partially magnetically insulated from each other through the strands touching at points only, and that in the direction in which magnetism would become developed, *i.e.*, at right angles to the line of flow. The argument as regards lightning conductors deserves the careful notice of manufacturers engaged in the erection of the same.

An Important Invention.—It is stated that an American has been giving the matter of improvements in ships' compasses and steering gear some attention, and has patented a pneumatic-electric device by which a ship can do her own steering and keep her own course. There is an electric connection with the binnacle at the point toward which it is desired she should steer, and any deviation from this by the motion of the vessel brings the pneumatic gear into work and acts upon the rudder. The invention has already been tested on board a United States steamer with a successful result.

Edison Central Stations in America.—The 1,600-light central station of the Edison Company at New Bedford, Mass., was ready for starting up about the first week in February. The New England Wiring Company has fitted up this station with all the inside wires and the wiring of the poles, while the Edison Tube Works Company, of New York City, has attended to the underground work.

A Miners' Electric Lamp.—At the recent conference of the Miners' Union, Mr. Burt, M.P., the president, observed that two things were very desirable in the way of lessening the number of explosions. One was the provision of a good useful light, and the other the abolition of blasting by gunpowder in fiery mines. We read in the *Times* that the first of these conditions appears to be met by an apparatus which is self-contained and consists of a chloride of silver battery composed of three cells, each 6 in. high by 3 in. wide and 1 in. deep. The current produced supplies a small glow lamp, of German manufacture, which is placed in front of the metallic case containing the battery after the fashion of the bull's-eye of a police lantern. The lamp is well protected, and is provided with a reflector, so that a good light is thrown forwards. The light given by this lamp is stated to be of 3 candle-power, and to be capable of burning for nine hours, but this, as far as candle-power goes, is in excess of the requirement of the miner, so that smaller sizes are made. The cells are hermetically sealed, so that the lamp can be used at any angle without fear of loss of the liquid or extinction of the light as with the ordinary miners' oil lamp, than which the new one is said to cost much less for maintenance. Upon this point, remarks our contemporary, it is to be observed that when the power of the cells is exhausted there is no waste of the elements. The chloride of silver will have become converted into pure silver, and can be revivified by washing in a solution of nitric and hydrochloric acid. The lamp and the battery are both locked against the miner, who cannot interfere with either. The lamp can be hooked up in the ordinary way, or attached to the miner's belt. It has, says the *Times*, had the approval of one of our leading electricians, and of several mining authorities subject to being tested.

[We fancy we can here recognise an old friend in a new guise.—EDS. ELEC. REV.]

Domestic Electric Lighting.—Osmaston Manor, near Ashbourne, on the occasion of a ball given by Sir Andrew Barclay Walker, Bart., on the 19th ult., was for the first time lighted by the electric light. Sir A. B. Walker having decided to permanently light the house, arranged that the Liverpool Electric Supply Company should carry out this work. In addition to the permanent lighting, a temporary installation was made in the conservatory and large portable ball room, which was fixed on the lawn. Although the time available was exceedingly short, Messrs. Holmes and Vaudrey decided, as far as possible, to put down the plant permanently, and on the evening of the ball the whole of the ground floor and stairway landing were provided with the special fittings which had been made to suit the various rooms. In these rooms, and in the conservatory and ball room, were distributed 200 16-C.P. incandescent lamps, The engine, which was fixed in a shed built for the purpose, is a 20 horse-power compound, of Messrs. Marshall's well-known make. The plant is capable of supplying between 300 and 400 lights, and it is arranged for a complete and permanent installation of this number.

Relative Cost of Different Sources of Light.—Lecturing recently at Stafford on "Sources of Light," Prof. W. F. Barratt, F.R.S.E., of the Royal College of Sciences, Dublin, comparing the different illuminating agents in use at the present moment, said that for the same amount of light, gas cost 6d., the glow electric light 6d., and the arc 3d. Paraffin oil occupied a very high position as an illuminant in cheapness and undeleterious nature of waste products, but its disagreeable smell and the danger attending its use were against it. Electricity gave rise to no deleterious products at all, but the arc lamp gave a dazzling though flickering light, throwing intense shadows. The arc light was far less expensive than the glow light. In calculating the cost of providing the electric light for a house, the chief item was the interest on capital laid down in plant; the actual supply of electric energy

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was the least of the items. For 200 lamps lighted 500 hours a year it was cheaper to have gas than the arc electric light. But in gas the chief cost was the consumption of gas, and when the number of hours a year in which the light burned was extended, the relative cost of the two systems was reversed. The great requisites for an artificial light were steadiness, accessibility, cheapness, safety, non-deleteriousness, and whiteness.

Gas not Infallible.—The *Globe* of the 1st inst. states that some excitement was caused in Skibbereen, county Cork, on Saturday night, owing to the gas suddenly going out. Doors were closed, as it was feared that the shops would be ransacked by marauders. The alarm was intensified by the twofold rumour of an explosion and conflagration in the gas house. Crowds rushed to the place to find that the large gasometer had given way. Candles had to be used until Sunday night, when the defect was remedied.

Secondary Battery Efficiency.—Mr. Bernard Drake writes to us as follows :—" I was reported to have said at the Society of Arts meeting, January 20th, that in the tests made at the Electrical Power Storage Company's works with the experimental tramcar, it was found that the efficiency in ampère hours was 75 per cent., and in watts 70 per cent., charging and discharging the cells considerably above the normal rate ; the figures I gave were 85 per cent. in ampère hours, and not 75 per cent. As the commercial efficiency of secondary batteries is commanding considerable attention, I trust you will find space for the above correction."

The Light of Other Days.—Mr. W. F. Thomas, the lessee of Covent Garden Theatre during the promenade concert season, thus expresses himself to Mr. F. R. Reeves, manager of the Jablochkoff Company :—" In reply to your enquiry respecting the electric lighting of Covent Garden Theatre during my promenade concert seasons, I have no hesitation in stating, after my experience of the Brush Company, in 1882, the Jablochkoff (old company), in 1883, the Maxim-Weston Company, in 1884, and the Jablochkoff (new company), 1885, that on both occasions your system has proved itself in this theatre more satisfactory and reliable than the others, and that both your arc and incandescent lighting here last year far excelled any previous attempts at lighting this theatre by electricity, and gave me great satisfaction. I would add my thanks to your Mr. Newington for his exertions in carrying out the lighting throughout." M. Riviere also states that the lighting during his tenure of office was Weldon, *i.e.*, done well.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Continental Etéve Engine Company, Limited.—An agreement dated 30th ult., and filed with the documents of this company on the 1st inst., provides for the allotment to Jean Andre de Braam and Eugene Etéve 400,000 fully paid shares in consideration of the sale and transfer of certain letters patent referred to in an agreement of 25th September, 1885.

London and Globe Telephone and Maintenance, Company, Limited.—The annual return of this company, made up to the 19th of August, 1885, was filed on the 29th ult. The nominal capital is £600,000 in £1 shares. 140,007 shares have been allotted and the full amount has been called thereon. The calls paid amount to £56,392 and unpaid to £945, and 82,670 shares are considered fully paid up.

Single Wire Multiple Telephone Company, Limited.—The annual return of this company, made up to the 12th ult., was filed on the 28th ult. The nominal capital is £5,000 in £10 shares. 194 shares have been taken up, and the full amount has been called and paid thereon.

United Telephone Company of the River Plate, Limited.—An extraordinary general meeting of this company was held at 131, Wool Exchange, Coleman Street, on the 28th December, when it was resolved "That the articles of association be altered as follows :—In article 72 the expression 'a member or' shall be substituted for the expression 'at least five.'" The resolution was confirmed at a meeting on the 12th ult., and duly filed on the 1st. The alterations bear reference to the right of members holding 1,000 shares to demand a poll.

New Electro-Amalgamator Company, Limited.—The statutory return of this company, made up to the 21st ult., was filed on the 28th ult. The nominal capital is £6,000 in £1 shares. 4,565 have been taken up, and the full amount has been called thereon. The calls paid amount to £3,339 and unpaid to £499. 727 shares are considered as fully paid.

CITY NOTES, REPORTS, MEETINGS, &c.

Cuba Submarine Telegraph Company, Limited.

THE half-yearly general meeting of this company was held at the offices, 61, Old Broad Street, E.C., on Wednesday, Mr. J. de Mancha presiding.

Mr. Scott, the Secretary, having read the notice convening the meeting,

The Chairman said they would see by the report that after providing for the portion due for the 1881 cable and other expenses, there was a sum of £8,641 for division. Taking into consideration the depression of trade all over the world, he thought they might consider the accounts satisfactory. Unfortunately they had had to suffer from the depression, for their business had declined somewhat, 500 less telegrams having been transmitted in the past six months, as compared with the corresponding six months of the previous year, decreasing their income by about £1,000. With regard to the paragraph in the report relating to the proposed Halifax-Bermuda cable, when they first saw the advertisement issued by the Government they thought it desirable to communicate with the friends connected with their line, with the view of preparing a scheme, and, if thought desirable, making an offer for laying the cable. They found, however, that some of their colleagues would not enter into the matter. At one time they thought that they and their friends in other companies might contribute together for the establishment of a company which might be formed to lay the cable, and then to come to the shareholders and ask them to take shares in the new company. But after due consideration they thought it advisable not to tender at all. The difficulties were very great; from the report that the *Challenger* had made to the Government, it was found that the depth was very great indeed, that in some cases the bottom was very rocky and very bad for laying down a cable, and that they would have had in some cases to go down to four miles, while, in case of any misfortune, it would be almost impossible to get up the cable again. They wrote to the Government, representing the injustice to this company, after it had been so many years in existence and had spent a large amount of money in keeping up communication with the West Indies, of subsidising another company. To that letter the Colonial Office replied that the Government could not depart from its decision, arrived at on grounds of public policy, to subsidise a cable between Halifax, Bermuda, and Jamaica. They took no further action, except to endeavour to ascertain whether other companies had offered to lay the cable. They wrote again to the Government, but had received no reply, and he supposed that with the elections and the probable change of Government, the matter had been allowed to drop. He hoped the line would not be laid, and that if it was some arrangement might be made whereby this company would not be prejudiced. Following the desire of some of the shareholders, the directors were reducing the amounts in some of the banks; but in these times of cheap money it was difficult to get 5 per cent., and some of the oldest and best banks in which they deposited had informed them that they could no longer pay 5 per cent., and offered 4½ per cent. interest. He moved that the report and accounts be adopted.

Mr. Low seconded.

Mr. D. W. Greig congratulated the directors upon their success in keeping the company in such a good state, and then called attention to an apparent diminution in the reserve fund. He also reminded them that there were two classes of shares, the 10 per cent. and the ordinary, and said it would be a great thing if they could by any possibility devise some means whereby both might sail in one boat.

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Mr. Goddard suggested that the company should gradually purchase the preference shares, or as many as possible, in the market.

Mr. Griffith strongly condemned the proposed action of the Government in laying down a cable from Halifax to Bermuda for which there was no military necessity and which could not be commercially successful. He pointed out that European telegrams could not be sent over that cable, because the Anglo-American Company was under agreement with the Western Union Company, over whose land lines all such traffic must go. Then this company was in agreement with the West India and Panama Telegraph Company, and the latter sent all messages from the West Indies through the Cuban cables, so that the new line would be ostracised altogether. He was not without hope that the scheme would be abandoned.

The Chairman, replying to the shareholders' remarks, explained that the reserve fund had not really been decreased, but there had been a transposition of figures upon the suggestion of the auditor. With regard to the preference shares, the question had been very much before them, but he did not think they had power to act upon Mr. Goddard's suggestion. Most of the preference shares were held by widows and others who liked to have their money secure, and it would be difficult to get them to consent to any change. If they paid 10 per cent. for five years upon the ordinary shares they might possibly, by paying a little bonus, get them to come in upon equal terms with the other shareholders.

Mr. Griffith said that, as a question of strict law, companies were not usually allowed to invest in their own shares, the objection being that it diminished the capital which the outside creditors could fall back upon. But it would be possible, he thought, to pass a resolution giving the board powers to buy up gradually. It was a matter of doubtful wisdom, however, and he could not say whether it would be expedient, or generally for the benefit of the company.

The resolution for the adoption of the report was then put and carried unanimously.

The Chairman next moved the declaration of dividends of 10 per cent. per annum, subject to income-tax, upon the preference shares, and of 7 per cent., free of income-tax, on the ordinary shares.

Mr. Low seconded, and the motion was carried.

Mr. Goddard moved a vote of thanks to the directors, which was accorded and acknowledged, and the meeting terminated.

Maxim-Weston Electric Company, Limited.

An extraordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Monday, under the presidency of Mr. Hugh Watt, M.P., for the purpose of confirming resolutions passed at a meeting reported in our last issue.

The Chairman said it was not necessary to repeat the arguments which he used when the resolutions were first placed before the shareholders as to the reasons which induced the board to arrive at the conclusion as to the desirability of reducing the amount, for virtually it was reducing the amount, to the debit of patents account, by reducing the capital of the company to 5s. per share. He hoped he made it clear on the last occasion that the directors considered the company, in view of existing circumstances, over-weighted by an amount of capital which, as far as the present board was concerned, they had never possessed. In his opinion no patents at the present moment were equal to those possessed by this company, but after a great deal of consideration he thought it would be to the interests of the shareholders to reduce to 5s. per share, thus bringing the patent account to something like £50,000 less than last year. One reason was the existing state of the electrical market. Nothing of an illusory character had been entertained by the company; they had taken an entirely commercial view of things, and endeavoured, as far as possible, to conduct the business as though it were a private enterprise. The result, in the opinion of the directors, was satisfactory; and they believed, when the reduction of the capital was completed, they would be able to greatly improve their position. Another reason for the change was the opinion of the solicitor and of counsel that it would have been impossible for them to have declared a dividend for the past year. The shareholders last year were good enough to express an opinion, in opposition to his recommendation to pay a dividend, as to the advisability of retaining the money as working capital. He would ask now for an equal degree of magnanimity, and that they would give some expression of opinion as to their wishes in regard to a dividend. He thought they ought to pay something. It was true the present board had not been in office ever since the floating of the original Electric Light and Power Company, but the shareholders who, like himself, invested at a high premium, naturally wanted some return for their money after some few years' delay. He then moved the confirmation of the resolution, "That the capital of the company be reduced by £62,500 by cancelling paid-up capital unrepresented by available assets (being patents over-estimated in value) to the extent of 5s. per share upon each of the 250,000 shares which have been issued and are now outstanding."

Mr. John Brown, a director, seconded this motion, which was carried without dissent.

The Chairman then moved the confirmation of the second resolution, "That the capital of the company be further reduced by £62,500 by reducing the nominal amount of the remaining 250,000 shares of the company's capital from 10s. to 5s. each, thereby leaving the nominal capital of the company £125,000 divided into 500,000 shares of 5s. each.

Mr. Louis Swaby, another director, seconded this resolution, which also was unanimously agreed to.

The Chairman repeated his desire to hear the opinions of the shareholders as to the amount of the dividend that should be declared, and gave a short statement showing the financial position of the company. The board deemed it advisable to pass the sum of £3,606 5s. to a general reserve account, being induced to do that by the fact that the late board had left, among other legacies, a probable bad debt of £1,700. After allowing for this sum, the balance remaining to the credit of the profit and loss account as at December 31st, 1885, was £5,285.

Mr. Griffith said after what the Chairman had told them, he thought all the shareholders would be of his opinion, and would willingly assent to the declaration of a dividend of 7½ per cent.

This was concurred in by several other shareholders, and the Chairman accepted the opinions expressed as a recommendation to guide the board in preparing for the annual meeting.

Mr. Griffith moved a vote of thanks to the Chairman and directors, which was heartily accorded, and in replying,

Mr. Watt made reference to the Electric Lighting Act of 1882, which had done much to retard electric lighting, the Lancashire Maxim-Weston Company having been entirely ruined by that Act, and spoke hopefully as to the prospects of securing an amelioration of the conditions it contained. The Bill of which he had given notice in Parliament had brought him letters from various gentlemen who were anxious to back his Bill and to assist him as far as possible.

Anglo-American Brush Electric Light Corporation, Limited.

The report of the directors for the year ended 31st December, 1885, states that the general prospects of the electric lighting industry have continued to improve, and although the advance has not been so great as was hoped for, the business and profits of the corporation have sufficiently increased to justify, in the opinion of the board, the distribution of a dividend.

The range of the business of the corporation has, during the past year, been largely extended. As a result of the absorption of the Great Western and Brush Midland Companies, reported on last year, important centres have been secured in South Wales and the West of England, and there is no reason to doubt that when the present legislative obstacles to central station lighting have been removed, the corporation will benefit by the connections which have been established. An important station has also been acquired at Manchester, while a branch office has been opened at Edinburgh.

The Continental work of the corporation has again been of a very encouraging character, and the agency for the German Empire, organised about 18 months back, especially promises further good results, the corporation having lately entered into an arrangement for the establishment of a central lighting station in an important part of Berlin. In view of the magnitude and increasing importance of the foreign interests and relations of the corporation, the board have recognised the necessity of having a representative abroad, and they have appointed Mr. Frank Wynne, who for the last two years held the post of general manager in England, to superintend the Continental work of the corporation.

The corporation are able to show a satisfactory record of practical work done during the year. In addition to the share of Government contracts for the supply of electric lighting apparatus which the corporation continue to receive, several profitable and interesting installations of the electric light have been carried out in docks, railway stations, collieries, factories, and private houses: also, as a somewhat new departure, a very successful installation has been completed upon the Duke of Bedford's yacht *Northumbria*, and upon others of a similar class. The International Inventions Exhibition afforded the corporation a favourable opportunity of bringing to the notice of the public the merits of their numerous patents, the commercial and scientific value of which was recognised by the award of a gold medal.

The superiority of the manufactures of the corporation has been fully maintained, and the fact of the corporation being the only firm in this country able to meet by their own manufactures the demand for both arc and incandescence apparatus, gives them a manifest advantage in the competition for business. The corporation may in a large measure take credit (by the construction and form of the "Victoria" dynamo) for the introduction of slow speeds for both dynamos and engines, whereby the general lighting of ships has been furthered. The attention of the corporation has also been directed to the production of motors to work in connection with Brush machines, and success in this branch of electrical work, the demand for which in the future is likely to be considerable, may be considered as assured.

In the last annual report the directors had the satisfaction of congratulating the shareholders upon the freedom of the corporation from litigation, and this immunity has happily continued during the past year. At the same time they intimated that they would regard it as their first duty to take such steps, with a view to the maintenance and protection of the valuable patent rights of the corporation, as might from time to time seem necessary. Since then the board have deemed it their duty to procure the recognition by other manufacturers of the rights of the corporation in respect of their patents and improvements, and the directors are glad to be able to report that the results of the

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steps taken have been satisfactory to the interests of the proprietary.

The shareholders have already been made acquainted by the half-yearly report issued in July last with the progress which has been made in the direction of obtaining an amendment of the Electric Lighting Act. The general election which has since taken place has undoubtedly strengthened the position then taken up, and abundant proof has been afforded of the increasing interest taken by the public in this question, and of their appreciation of the necessity for further legislation in this matter. It is under these circumstances a great source of congratulation to your directors that the draft Bill prepared last year by the Electric Lighting Committee, which held their meetings in your offices, has been taken as the basis of a measure to be shortly submitted to the House of Lords by Lord Rayleigh.

It will be seen from the balance sheet that the called-up capital stands at £190,174. This is a diminution upon the figure at which capital stood last year of £795, due to the maximum number of shares to be issued to the members of the Great Western and Brush Midland Companies having been reduced by 159 shares in consequence of arrangements, advantageous to the corporation, made with some of the shareholders of the Midland Company, by which they relinquished their claim to these shares in consideration of the liquidators accepting the difference only between the amounts of the call due by them and the value of the shares in the corporation to which they would have become entitled upon paying the call in full.

The total amount owing by the corporation to creditors is £6,233 17s. 2d., as against £3,726 6s. 4d. in 1884, while the good debts due to the corporation, together with cash at bankers, amount to £39,563 1s. 2d., as against £30,102 0s. 10d. last year, a comparison which will serve to indicate to some extent the improvement which has been effected in the financial position of the corporation during the year.

The contra items representing shares held by the corporation in other companies and provision against same have been reduced by £36,000, the amount of the shares which the corporation held in the Anglo-Spanish Company. These shares have been relinquished by the corporation in consideration of that company paying £500 in cash, and re-assigning the Brush and Lane Fox patents for Spain to the corporation. This leaves the disposal of the Spanish patents again in the hands of the corporation, and indications are not wanting to justify the hopes of satisfactory and profitable business spring up in this direction.

The patents and goodwill account has been increased by £12,536 6s. 4d., about £11,000 of which represents the consideration paid in shares of the corporation to the Great Western and Brush Midland companies for the surrender of their licenses and the goodwill of their business. The reason for the amount of this consideration being larger than the estimate contained in the last annual report is, that some of the other assets transferred by these companies to the corporation have, in consequence of the reduced valuation of the plant and stores of the corporation, been merged into the books at figures much below the original and otherwise perfectly justifiable estimates. The other items making up the increase of patents and goodwill account represent the cost of maintaining the English and foreign patents, and of developing and securing patent protection for several recent inventions, adding very materially to the aggregate value of the property in patents held by the corporation. It should also be remarked that the value of the asset represented by this account has been still further enhanced by, though the figure has not been augmented in respect of, the reversion of the Spanish patents to the corporation referred to in the previous paragraph, and the directors entertain the conviction that the patents held by the corporation stand in the accounts at a figure so low as to be out of all proportion to their value—a circumstance that has of course a most favourable bearing on the value of the share capital of the corporation, and renders it unnecessary to reduce the amount at which patents now stand in the books.

The property account shows an increase upon last year's figure of £11,786 8s. 10d., which is mainly due to the acquisition of the freehold and leasehold land and buildings and plant of the Great Western and Brush Midland Companies at Cardiff, Bristol, Cleethorpes, and other places, and to the purchase of the Central Generating Station at Manchester, already referred to. The stock account, whieh stands at £69,626 13s. 7d., shows no material alteration in the aggregate value of the stock on hand (taken at the valuation mentioned in the last annual report), stores and goods in course of manufacture.

The amount of £1,699 11s. 6d. standing to the credit of assets realisation account represents the residue of the assets of the Great Western and Brush Midland Companies still to be transferred to the corporation by the liquidators. Should the assets still in the hands of the latter not realise this amount the deficiency will be added to the cost of the goodwill &c., of these companies, in accordance with the principle laid down in the last annual report.

The profit and loss account shows a gross profit of £20,935 9s. 3d. after providing for bad and doubtful debts, and including the £500 received from the Anglo-Spanish Company, mentioned in paragraph 11. After deducting all standing charges and expenses there remains a balance to credit of profit and loss account, including the balance of £1,627 15s. 4d. brought forward from last year, of £6,728 6s. 8d. The standing charges, it will be noted, show an increase in the aggregate of £1,140 17s. 2d. This is due partly to the higher premiums now generally demanded by fire insurance companies, to additional advertising, travelling, and to such other expenses as are directly attributable to the larger volume of business transacted by the corporation during the year, and to the steps taken in furtherance of increased future developments.

The board recommend that £2,000 be applied to the reduction of properties and plant account, that £3,803 9s. 7d. be applied to the payment of a dividend at the rate of 2 per cent. per annum on the whole share capital of the corporation, and that the balance of £924 17s. 1d. be carried forward to next account.

The directors consider that there is good ground for encouragement in the prospects of business during the current year. The corporation have already secured important contracts for lighting portions of the various exhibitions to be held during the summer, and there is reason to hope that the negotiations which have been carried on during the past two years with the Corporation of the City of London for lighting an extended area are now approaching a satisfactory termination. The directors also look for an accession of business to the recent adoption by the corporation of the policy of supplying and erecting electric lighting apparatus upon the purchase hire system, by which payments may be extended over a period of three years.

Balance-sheet :— Dr. — To capital, £190,174; to creditors, £6,233 17s. 2d.; to provision for shares in other companies, £14,000; to balance of profit and loss account, £6,728 6s. 8d.; total, £217,136 3s. 10d. Cr.—By patents, £39,712 19s. 3d.; by property, £51,933 18s. 4d.; by stock, £69,626 13s. 7d.; by debtors, £32,969 7s. 2d.; by cash, £6,593 14s.; by shares and debentures in subsidiary and other companies, £14,600; by assets realisation account, being balance of assets still to be dealt with by the liquidators of the Great Western and Brush Midland Electric Light Companies, £1,699 11s. 6d.; total, £217,136 3s. 10d.

Anglo-American Telegraph Company, Limited.

THE report of the directors to be presented at the meeting of the proprietors, to-day (Friday), states that the total receipts from the 1st July to the 31st December, 1885, including a balance of £5,343 5s. 7d. brought forward from the last account, amount to £155,799 3s. 5d. The traffic receipts show a decrease as compared with the corresponding period of last year of £93,926, consequent upon competition, a reduced tariff, and continued depression of trade between Europe and America.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £49,202 9s. 10d.

The directors, under the powers conferred upon them by the articles of association, have, before declaring the nett profits, set apart the sum of £50,000 to the renewal fund, leaving a balance of £56,596 13s. 7d.

Interim dividends of 5s. per cent. on the ordinary stock, and 10s. per cent. on the preferred stock, were paid on the 1st November last, absorbing £17,500, leaving a balance of £39,096 13s. 7d. out of which the directors recommend the proprietors to declare final dividends of 10s. per cent. on the ordinary stock, and £1 per cent. on the preferred stock, amounting to £35,000, making a total distribution for the year ended the 31st December, 1885, of £1 5s. per cent. on the ordinary stock, and £2 10s. per cent. on the preferred stock, leaving a balance of £4,096 13s. 7d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during a portion of the past half-year in the repair of the Brest, Duxbury, Placentia and Island Cove cables. She has also effected the repairs of two main cables belonging to the Western Union Telegraph Company, and of the main and short sections of the Direct United States Cable Company, having been chartered to those companies for the purpose.

The company's system of cables and land wires is in good working order.

The competition with the Commercial Cable Company (Mackay-Bennett Cables) still continues. The loss caused by the reduction of rate from 2s. to 1s. 8d., estimated in the report of the directors dated 29th January, 1885, at £170,000 a year, has amounted to more than that sum, as it has not been followed by any augmentation of the traffic.

Branch offices have been opened during the past year, at the expense of the Associated Cable Companies, at Glasgow, Bristol, and Havre.

Since the report was printed a circular has been issued by Mr. Jeremiah Stockdale, hon. sec. of a "Shareholders' Association" recently formed at a meeting in London, at which about 25 persons were present.

The only communication made by the association to the Board is contained in the annexed letter of the 21st instant, to which a reply was sent on the 23rd, copy of which is also annexed.

From this correspondence it will be seen that Mr. Stockdale was distinctly informed that the resolution, which he now asks the proprietors to support by their proxies, cannot legally be put to, or voted upon, at the meeting on the 5th February.

The directors are advised by eminent counsel that no resolution of a general meeting can release directors from the duty expressly laid upon them by the articles of association to exercise their own judgment upon the amount to be set apart for the renewal of the company's cables. Under these circumstances the directors do not think it needful, even if there were time, to answer the statements in Mr. Stockdale's circular.

The views of the directors on the subject were explained in the last report, and they see no reason to alter the opinions therein

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expressed, and which were then endorsed by the votes of an enormous majority of the proprietors.

If the Shareholders' Association accept the suggestion made to them to convene an extraordinary meeting, every facility will be afforded for the full discussion of the question.

The correspondence alluded to consisted of a letter from Mr. Stockdale to the directors giving notice that at the half-yearly meeting, Mr. Thomas Smith, of York, would move this resolution:—"That with the exception of accruing interest, no further addition be made to the so called renewal fund, as from 1st January, 1886"; and the reply of the secretary in the terms stated.

Telephone Company of Austria, Limited.

THE report of the directors of this company for the period since the formation of the company to the 30th of June, 1885, states that as this is the first report issued by the company the board deem it advisable to submit to the shareholders a few facts which will place the position of the company more clearly before them. They remind them that in July, 1884, the affairs of the company had reached such a point that it became a question whether the concessions would not be forfeited. By vigorous efforts a thorough reorganisation was commenced by the present board, capital found to continue the installations, arrangements concluded with the concessionaires in Austria, debentures issued for the debt which has been incurred, and the whole management thoroughly examined into. The result of this policy is stated to have been very satisfactory. On the 30th of June, 1884, the number of subscribers to the exchange and private lines was 626, the annual income being 51,579 fl. On the 30th of June, 1885, these totals were 1,012 and 86,303 fl. respectively, and on the 31st of December, 1885, they were 1,246 and 102,831 fl. respectively. To make the period of accounts correspond with the financial year of the parent company (the Consolidated Telephone Construction and Maintenance Company), and as required by the Austrian Government, it is proposed to issue a further balance sheet in May next, comprising the accounts of the company for the nine months from July 1st, 1885, to March 31st, 1886; the latter date will in future be the end of the company's financial year, and accounts, with the directors' report, will be issued in May following.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited.—Subject to audit, the company's accounts to 31st December last show the following result:—Brought forward from 1884, £40,070; premium on new shares issued in 1885, £52,394; net profit for 1885, £65,862—£158,326; less interim dividend paid in July, 1885, 5 per cent., £20,779. Total, £137,547. The directors have to-day resolved as follows:—To add to reserve fund (including premium on new shares), £55,000; to recommend a dividend of 10 per cent. (making 15 per cent. for 1885), £41,600; to carry forward to 1886, £40,947. Total, £137,547.

The National Telephone Company, Limited.—The directors have resolved to declare an interim dividend for the six months ending December 31st last at the rate of six per cent. per annum on the first and second preference shares, and at the rate of three per cent. (as against two per cent. for the corresponding period last year) on the ordinary shares, £2,685 being carried forward. The unaccrued revenue carried forward to the credit of next account amounts to £34,058, as against £29,995 last year.

Submarine Telegraph Company, Limited.—The accounts for the half year ending December 31st last, submitted to the board, show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 14¼ per cent. per annum.

Edwin Fox and Company, Limited.—Applications are invited for 2,458 shares in this company, which was formed in 1882 to take over the business of that firm known as the Magnetic Telegraph Wire Works, at Millwall. The capital is £50,000 in £10 shares, of which 2,542 have already been taken.

The Maxim-Weston Electric Company, Limited.—The directors have decided to pass a sum of £3,600 to a general reserve account, and to recommend a dividend of 7½ per cent. for the past year, carrying forward a balance of about £600 to next year.

Eastern Telegraph Company, Limited.—This company notifies that the coupons on its 5 per cent. debentures, due on the 14th inst., will be paid at the banking-house of Messrs. Glyn, Mills, Currie & Co.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of January was 3,485, estimated to produce £2,850, against 3,555 messages, producing £3,013 in the corresponding month of last year. The receipts for the month of October, estimated at £2,100, realised £2,156.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st January are £2,799, as compared with £2,766 in the corresponding period of 1885. The October receipts estimated at £3,894, realised £3,940.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 29th were £2,438, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January were £1,656, against £1,756 in the corresponding period of last year.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

THE first ordinary general meeting for the year of this society was held on Thursday, January 28th, Mr. C. E. SPAGNOLETTI, Past-President, in the chair. The ordinary formal business of the meeting having been concluded, the new President for the year, Prof. D. E. HUGHES, F.R.S., read his inaugural address as follows:—

Before commencing the subject of my address this evening, I desire to express my sincere thanks to the members of the Society of Telegraph-Engineers and Electricians for the great honour they have conferred on me by electing me as their president, and to assure them that I will do all in my power to aid and promote the interests of our society, which are those of applied science in one of its highest branches.

It is the custom in our society, that the elected president should open the session by an address containing a general review of the present state of electrical science, or researches in some special branch which may be of interest. I have chosen the latter, as it enables me to present to you some researches which I have not yet published, and I propose to present these in the form of a paper rather than an address, in order to allow our members the opportunity of a full discussion on the subject, which I hope may bring forth many new facts in their possession.

The subject which I have chosen is—

THE SELF-INDUCTION OF AN ELECTRIC CURRENT IN RELATION TO THE NATURE AND FORM OF ITS CONDUCTOR.

Induced or secondary currents in a near but independent circuit were discovered by Faraday in 1831; and the phenomenon of the self-induction of an electric current in its own wire was observed by Henry in 1832, and traced to its cause in 1834 by Faraday, who proved that on sending a current through a wire a momentary induced current in the opposite direction is evoked in its own wire; also that, on the cessation of the primary current, a second induced or "*extra current*" is excited in the direction of the primary. The effect is greatly augmented when the wire forms a coil, as we then have in addition the reaction of superposed currents; but the effect exists to a great extent even when the wire forms but a single loop, or a straight wire with the earth forming the returning portion of the loop, as in all telegraph lines.

It has been generally supposed that the nature or the molecular condition of the metal through which the primary current passed exerted no influence upon the extra currents except that due to its resistance. I have previously pointed out* that for induced currents "the rapidity of discharge has no direct relation with the electrical conductivity of the metal, for copper is much slower than zinc, and they are both superior to iron." This led me to make a study of these extra currents, for which purpose I constructed a special induction bridge, in order to measure both the primary and its extra currents separately at the instant of action.

INDUCTION BRIDGE.

This instrument is a combination of a portion of my "induction balance," with a "Wheatstone bridge." The resistance of the wire is measured and balanced by the bridge; the induced or extra currents are measured and reduced to zero by an equal opposed induced current from the induction balance.

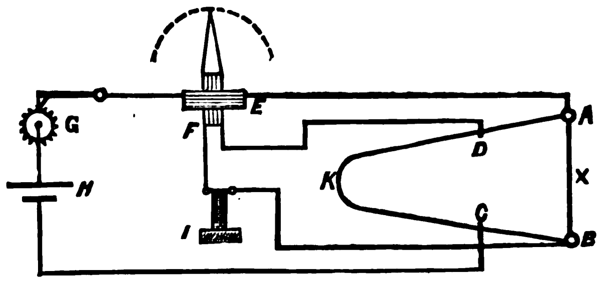

FIG. 1.

The above diagram shows the electrical communications. The bridge consists of a single German silver wire (0·25 mm. diameter, 1 metre in length, of 4 ohms resistance) running from A to K, returning to B. The wire is stretched and sustained upon two wooden arms articulated at K, by means of which the terminals, A, B, can be more or less separated as desired. The wire to be tested, X, is joined at A and B, thus completing the closed circuit of the bridge.

The external communications are shown, A being connected to the primary coil of the sonometer, E, and through it to the spring of the interruptor or rheotome, G, the interrupting wheel being connected to the battery, H, and thence to the bridge at C. The wire from B passes through the telephone, I, to the secondary coil, F, returning to D.

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* "Induction Current Balance," *Proc. Roy. Soc.*, vol. xxix., p. 56, 1879; "Molecular Electro-magnetic Induction," *Proc. Roy. Soc.*, March 7th, 1881.

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Great care has to be taken in the construction of the bridge, so that it shall be as free as possible from induced or extra currents; and for this reason we cannot employ or introduce resistance coils. The resistance of the wire, X, is balanced by sliding the communications, D and C. It is evident that if all the arms of this bridge are equal in resistance and inductive capacity, there will be silence on the telephone; but if A, B be slightly stronger or weaker in inductive capacity, then we may be able to balance its resistance, but not its induction, as we shall then have a slight or a loud continuous sound due to the differential extra currents in the arm, A, B. These are compensated by the introduction in the circuit of the telephone of an equivalent but opposed induced current from the secondary coil of the sonometer, F, the degree of angle through which this coil has turned to produce silence being the degree of force of the extra current. The induction sonometer * consists of two coils only, one of which is smaller and turns freely in the centre of the outside coil. The exterior coil being stationary, the centre coil turns upon an axle by means of a long (20 cm.) arm, or pointer, the point of which moves over a graduated arc or circle. Whenever the axis of the interior coil is perpendicular to the exterior coil no induction takes place, and we have a perfect zero; by turning the interior coil through any degree we have a current proportional to this angle, and in the direction in which it is turned. The value of the induction current for each sonometric degree was $\frac{1}{1800}$ of the primary current which passed through the wire under observation, the latter being variable at will from ·001 to ·250 ampère. There is also a reversing key (not shown in the diagram), in order to place the interruptor on the telephone circuit and close the battery current from H to A; the conditions then being the usual method of testing, except using the telephone in place of a galvanometer—a well-known method. The telephone, being exceedingly sensitive and rapid, is most suitable, whilst a galvanometer would be too slow, and its use, in fact, impossible for the researches I have been making.

Numerous details have been necessarily omitted in this rough sketch of the instrument. Suffice it to say that it is perfectly adapted for the object sought, viz., the investigation and measurement of the self-induction which takes place in all wires.

By all previous methods the measurement of the resistance of a wire is taken when the current has been already some time in action, or, to use an expression of M. Gaugain, when the electricity has arrived at its "stable period." In telegraphy, electric lighting, and all applications using rapid electrical changes, another period has to be considered, viz., that during the rise and fall of the current; this he named "the variable period," and it is in this period that all the phenomena of induction take place.

To observe the *stable* period, the current is continuously passed through the bridge (and consequently through the wire under observation), and the interruptor being placed in the telephone circuit allows us to find the exact resistance of the wire, free from all induction or change in the wire itself.

To observe the *variable* period, the interruptor or rheotome (making at will from 10 to 100 contacts per second) is placed on the battery circuit, the telephone being joined as shown in the diagram.

By means of a switch or a reversing key these changes are made as rapidly and often as desired.

If there were no static or self-induction, no loss of time, or change of resistance, then the result from these two periods would be equal; but this is never the case, for we find that when the resistance is balanced to a perfect zero for the stable period, loud sounds are given out in the variable period, requiring a fresh adjustment or balancing of the resistance of the wire, as well as a compensating opposing induction current from the sonometer to balance the self-induction. If we balance the resistance or the extra currents alone there is no possible zero, but when both are compensated we find at once a perfect zero for the resistance of the wire, and for its extra currents.

INDUCTIVE CAPACITY OF METALS.

The results of the following experiments prove that the force and duration of the extra currents depend upon the kind of metal employed as a conductor, its molecular condition, and the form given to the conductor, independent of its resistance or the electromotive force of the primary current. The increase of force by increased length is proportional to the length of wire less its additional resistance, but with wires of the same length increased cross section or diminished resistance does not produce a corresponding increase in the electromotive force of the extra currents.

The time of charge and discharge of the wire is independent of the electromotive force of the extra currents; for, if we compare currents of equal electromotive force obtained from copper and iron, it will be found that the duration of these currents in wires of 1 mm. diameter will be seven times slower in iron than in copper, and a still greater difference will be found in larger wires. The longest or slowest charge and discharge take place in the purest soft iron, and have a constant ratio of increase with increased diameter of the wire; my experiments giving for wires of double the previous section, or for wires of four times less resistance, a mean increase of three times its previous duration.

* *Comptes Rendus de l'Académie des Sciences*, Paris, December 30th, 1878, and January 20th, 1879; *Proc. Roy. Soc.*, vol. xxxi., p. 527, 1881.

The electromotive force of the extra current in different metals will be seen in the following table, and in order that the values obtained from the sonometer may be clearly understood I have reduced the results to comparative values.

The table of values were obtained on wires of similar length, having been repeated on a similar series of lengths ranging from 10 cm. to 5 metres. The instrument is sufficiently sensitive for pieces only 10 cm. in length, and the results from the short lengths were as pronounced and accurate as those for greater lengths. I may add that the instrument shows no effects or traces of static charge for the lengths mentioned.

TABLE I.

WIRES 1 MM. IN DIAMETER, 30 CM. IN LENGTH.

Soft Swedish iron ...	100	Copper	20
Soft puddled iron ...	78	Brass	13
Swedish iron, not softened	55	Zinc*	12
Soft cast steel	41	Lead	10
Nickel*	34	German silver ...	7
Hardened cast steel ...	28	Mercury*	2
Cobalt*	24	Carbon*	1

* Being unable to procure wires of these metals, they were tested in the form of strips, and compared with similar strips of copper. Mercury was in a glass tube 2 mm. in diameter; carbon tested in the form of electric light carbon from 3 mm. to 10 mm.

The above table is only true for wires of 1 mm. diameter, as the effect depends on the size of the wire in relation to the nature of the metal. In soft Swedish iron a diminution in the electromotive force of the extra currents takes place with each increase in its section, and this has been partially foreseen by Maxwell,* who said: "The electromotive force arising from the induction of the current on itself is different in different parts of the section of the wire, being in general a function of the distance from the axis of the wire as well as time."

From this I expected that the increase (? decrease.—EDS. ELEC. REV.) of electromotive force by an increased section would not increase directly as its sectional increase; but I was not prepared to find, as my experiments prove, that after a certain maximum diameter of wire has been reached a marked decrease in electromotive force takes place with each further sectional increase, and that this maximum is variable with each metal.

The diagram shows a rapid rise of force in soft iron from an extremely fine wire of 0·10 mm. section to a maximum at 1 mm., from which point there is a slow but continued decrease of force with each increase in the size of the wire, until at the comparatively great diameter of wire of 10 mm. the force is but a fraction more than in the extremely fine wire.

Hard Swedish iron has a less initial force in the fine wire, and does not arrive at its maximum until the wire has 3 mm. diameter, being then nearly of the same force as soft iron of the same diameter; the fall from this point is somewhat similar, but less than soft iron until at 8 and 10 mm.; soft and hard iron have absolutely the same values.

A curious change of values at different diameters will be seen in copper and brass. Copper, having nearly double the initial force in fine wires, arrives at its maximum at 4 mm.; but brass creeps slowly up, passing copper at 5 mm., arriving at its maximum at 6 mm., and finally, in the large section 10 mm., it has more force than copper, their positions being completely reversed.

I have been unable to obtain wires of different diameters of other metals; but zinc rods of 10 mm. gave a still higher rate than brass, whilst in small diameters its force was less. For non-magnetic metals it is probable that the greater the specific resistance of the metal the greater will be the diameter of the wire before the fall commences.

Carbon is remarkably free from self-induction, and although there is a rise of force in rods of of 3 mm. to 10 mm., it is so small as to be hardly measurable. German silver rises with comparative rapidity, indicating that with wires of 20 mm. its force would equal that of copper. Carbon therefore seems peculiarly adapted as a resistance when used in the variable period of electric currents.

INFLUENCE OF PARALLEL CURRENTS.

The instrument being well adapted for showing the slightest change in the self-induction by the reaction of one portion of the current upon the other when in the same direction, as in a coil, or in the opposite direction, as in a parallel return wire, I made a series of experiments in order to observe the influence of different metallic conductors in this respect.

Two silk-covered iron and copper wires of similar diameter and length (1 mm. diam., 2 metres in length) were each formed in a single loop of 66 cm. diameter. The extra currents from iron were, as usual, six times stronger than those from a similar loop of copper. On closing the loop by bringing the opposite sides in close proximity and thus making a parallel return wire (the current ascending on one side and descending the other), I found that the reaction of currents in opposite direction was very different with different metals, the results depending more upon the nature of the metal than upon the proximity of the wires.

There was a reduction of the previous force of the extra currents in iron, when forming a parallel return wire, of 15 per cent., whilst the reduction in copper was 80 per cent. Thus the

* "Electricity and Magnetism," vol. ii., p. 291.

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currents in copper are far more influenced by an external wire than those in iron; consequently a telephone line having its return wire in close proximity should invariably be of copper, as not only is its specific inductive capacity less, but this is again reduced by the return wire, so that its self-induction is far below that of iron.

In order to observe the influence of currents in the same direction, the same wires were formed into a close coil of twelve turns of 2 cm. diameter; and from the known effects of parallel currents in the same direction we should expect a greatly increased effect. It was so in the case of copper, but iron was far less under the influence of an external parallel current; the strength of current in iron when formed into a coil being 57 per cent. greater than that of a single wide loop, whilst in copper the increase was 404 per cent., or seven times the increase of iron; and although iron when in a single wide loop had six times the force of copper, the comparative strength was reversed when the wires were wound as a coil, the extra currents from the copper coil then having 14 per cent. greater strength than that from iron, and this difference could be rendered more evident by employing longer wires.

Thus copper, as regards extra currents, is far more sensitive to the influence of external currents than iron, and the true self-induction from its own current can only be obtained by a straight wire, where the return wire is at such a distance that its influence is not appreciable.

Reaction of Contiguous Portions of the same Current.

It is well known that currents in separate portions of the same wire (as in a coil) react upon each other, and I felt convinced from the preceding experiment that self-induction is entirely due to similar electro-magnetic reactions between contiguous portions of the current in its own wire. Let us assume that an electric current consists of a bundle or an almost infinite number of parallel currents, the limit being a single line of consecutive molecules; then each line of current should by its electro-magnetic action react on each of the others similarly to wires conveying separate portions of the current, and the self-induction should be at its maximum when the lines are in the closest possible proximity, as in a conductor of circular section, and far less when separated, as in one of ribbon form, where the outlying portions are separated by a comparatively great distance: there would still remain, in the latter case, the reactions from the near portions on each other, and these should again be reduced by cutting the ribbon into a number of thin narrow strips separated, except at their junction, to a sufficient distance to prevent any marked reaction.

My experiments prove that this assumption is an experimental fact; for we can reduce the self-induction of a current upon itself to a mere fraction of its previous force by simply separating as indicated the contiguous portions of a current from each other, the results proving that a comparatively small separation, such as is obtained by employing ribbon conductors in place of a wire of the same weight, reduces the self-induction 80 per cent. in iron and 35 per cent. in copper; and if we still divide the current by cutting the ribbon into several, say 16, strips (separating the strips at least 1 cm. from each other), then the combined but separated strips show a still greater reduction, being 94 per cent. in iron and 75 per cent. in copper.

The following table shows the comparative reduction of self-induction by employing ribbons and parallel separated wires :—

Table II.

Flat Strips compared with Round Wire 30 cm. in length.	Copper.	Iron.	Parallel Wires 30 cm. in length.	Copper.	Iron.
Wire 1 mm. diameter ..	20	100	Wire 1 mm. diameter..	20	100
Strips.			Single Wire.		
0·25 mm. thick, 2 mm. wide ...	15	35	0·25 mm. diameter	16	48
Same, 5 mm. wide	13	20	Two similar wires	12	30
„ 10 „ „	11	15	Four „ „	9	18
„ 20 „ „	10	14	Eight „ „	8	10
„ 40 „ „	9	13	Sixteen „ „	7	6
Same, strip rolled up in the form of wire	17	15	Same, 16 wires bound close together ...	18	12

The resistance of a conductor, or even the nature of its metal, has less influence on its self induction than the form given to that conductor, the 1 mm. wire in the above table having a less resistance than the strip of 2 mm. wide, and a greater than any of the wider strips; but through all these variations we notice a gradual fall from the wire to the widest strip or ribbon, with a marked return to its previous force when the ribbon is rolled up in the form of a wire.

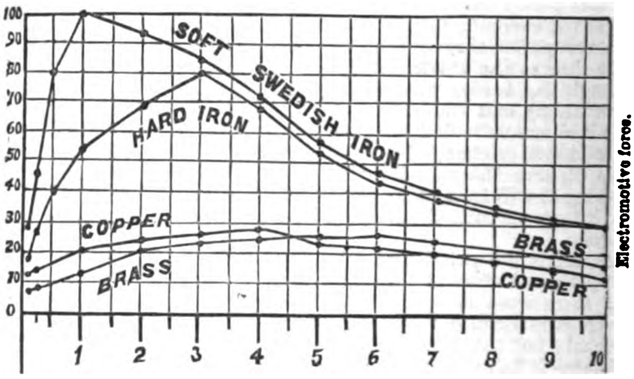
The reduction is greater in iron than copper, but its increase when rolled up is less than copper, thus agreeing with the previous observations on the difference of iron and copper to external reactions.

A still greater reduction takes place when we separate a current by using parallel wires separated 2 cm. from each other, as shown in the table. We then have a similar reduction to that produced by cutting the strips into several separate conductors; and we again remark that when the wires are brought close together (forming a stranded wire) copper rises in a far greater proportion than iron, the 16 fine iron wires twisted together as a stranded wire having 88 per cent. less induction than a solid wire of similar weight; a remarkable fact being that whilst a solid iron wire has an inductive capacity 80 per cent. greater than a solid copper wire, this is completely reversed when each metal forms a stranded wire of the same weight as the solid, for iron then has 33 per cent. less self-induction than copper.

It is not necessary to use extremely fine wires when we desire to reduce the inductive capacity of iron to that of copper, for I have formed stranded wire rope of 16 strands of wire where each wire was 1 mm. in diameter, giving 75 per cent. less induction than a solid wire of the same resistance. I purchased an ordinary wire rope of 6 mm. diameter, having 6 strands of 6 wires, each 0·5 mm. diameter; this gave the best result yet obtained, for, on comparing 3 mètres of it with a similar length of solid iron wire of the same resistance, the 36-stranded wire had only 5 per cent. of the amount of induction shown by the solid wire.

Steel, in the form of ribbon or stranded wires, shows a similar effect to that of iron; and it is a remarkable fact that, whilst the extra currents from a steel or iron wire 4 mm. in diameter are extremely slow, and impossible to balance without reducing the time of the sonometer current (by the introduction of an iron core), the ribbon or stranded wire requires no such compensation, for its feeble extra current is exceedingly sharp, and can be balanced to a perfect zero, being actually quicker than that of a solid wire of copper of the same resistance. This fact I regard as one of great importance for telegraph lines and lightning conductors.

A curious effect takes place if we employ mixed conductors, such as a compound wire of copper and iron. A fine coating of copper reduces the induction in a solid iron wire in a marked degree. This I found to be due to the difference of electromotive force of the extra currents in the two metals, for, by employing a fine copper wire parallel with an iron wire, and in contact at the ends, the extra current was reduced 60 per cent. The copper wire, having a lower electromotive force, probably acts as a shunt; but if the capacity of the iron has already been reduced, as in a sheet or stranded wires, then the addition of a single copper strand increases the force, as the electromotive force of the extra currents of copper is above that of stranded iron.



Diameter of wires in millimetres.

There has been for many years a discussion as to the merits of the round form as compared with the tape or ribbon form for lightning conductors. Those in favour of the former based their conclusions on experiments which gave a negative or no apparent difference between the two forms of conductors. Those in favour of ribbon conductors, as Sir W. Snow Harris, Professor Guillemin, and many others, based their opinion upon marked differences found when using high charges of static electricity. The latter supposed that there was a difference between discharges of static electricity and voltaic currents of low tension, and that the advantage recognised by almost conclusive experiments was due in a great measure to conduction by surface.

In the year 1864, Professor Guillemin and myself, as members of the Commission de Perfectionment of the French Telegraph Administration, were charged with the mission of testing the comparative merits of the lightning protectors then used upon their lines.

Our method of experimenting consisted in joining an insulated conductor to a short fine iron wire connected directly with the earth return wire. A Leyden jar battery charged by a Ruhmkorff coil was discharged through this conductor, burning or deflagrating the fine iron wire. This wire represented the telegraph instrument requiring protection, and by placing the lightning protector connected with the earth in advance of the fine iron wire we could observe the amount of protection afforded. This answered extremely well for feeble discharges, but with the full power of our battery the fine iron wire was invariably destroyed, even with the best lightning protectors which are universally used to this day. Noticing that we could not give absolute protection to the fine wire by lightning protectors, we tried the effect of joining the conductor direct to a separate earth wire in advance of the fine wire, and with powerful discharges the wire beyond the protection was invariably burnt, notwithstanding that we

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connected the conductor direct to earth by a copper stranded wire of 1 cm. diameter.

Professor Guillemin continued these experiments after my departure for Russia, and he found, by employing a thin sheet of copper as a conductor to earth in place of the copper stranded wire placed in advance of the fine iron wire, that the wire could be perfectly protected. The theory of this action was not understood at the time, and the experiment has not received the attention it deserved; but the mutual reactions of contiguous currents shown in this paper explain the phenomenon in the fullest degree, for we see that a sheet or ribbon conductor has far less self-induction than a wire or rod of the same material.

I am fully convinced from the results of my experiments that an enormous retardation or resistance is evident in all conductors at the first portion of the variable period, and that this is due to self-induction, the current thus arousing an antagonist in its own path sufficiently powerful, when the primary current has a high electromotive force, to deflagrate or separate the wire into its constituent separate molecules, as shown by Dr. Warren de la Rue.

It is also evident from my experiments—which are easily repeated, with invariable results—that a flat conductor has far less self-induction than a solid or circular section during the variable period; and even with a constant current, as in the stable period, this form of conductor, as first shown by Professor George Forbes, would, from its greater radiation, convey more current with less heating than a wire or rod of the same resistance.

Lightning conductors are intended to convey a current of high intensity during an exceedingly short time, and should therefore be designed so as to convey this current with as little opposition from self-induction as possible; consequently I regard a solid rod of iron as the worst possible form for a lightning conductor. The conductor, if of copper, should be of ribbon form, say 1 mm. by 10 cm. wide, or if of iron, of numerous stranded wires or a wide ribbon of similar conductivity to that of the copper.

SELF-INDUCTION OF A TELEGRAPH LINE.

A telegraph line may be considered as a single loop: the earth taking the place of a return wire can only affect the self-induction by a diminution of its effects, as in the case of a parallel return wire.

Mr. W. H. Preece has lately read a most valuable paper on "The Relative Merits of Iron and Copper wire for Telegraph Lines,"* in which he shows, by comparative rates of speed with the same instrument, that on a copper and an iron line of 278 miles in length (between London and Newcastle), whose resistance and static capacity were rendered equal, there was an increase of speed in the copper line of 12·9 per cent. as compared with an iron wire.

I have not been able to test the relative speeds obtainable by telegraph instruments on wires of different material. The results in every case would depend very much on the apparatus employed, but I have considered the question from a point of view independent of the instruments.

There is a remarkable difference in the resistance of a wire during the stable and the variable period, the measurements taken in the stable period giving no real or approximate idea of what its resistance really is during the rise of the current in the wire.

A curious fact in relation to telegraphy is that all measurements are made during the period of a constant flow of current, whilst all instruments—particularly those requiring rapid changes in the current—work only during the rise and fall of the current, as in the variable period. Telegraph engineers, however, have not made the mistake of assuming that there is no difference in the resistance of a wire in these two periods, as it is well known that electro-magnets and coils have a far higher resistance during the rise and fall of a current, and coils simply augment the effect of a straight wire of a given length.

The present method of testing by Wheatstone bridge has been adopted because we had no practical means of measuring the resistance in the variable period; and I do not believe that this can be accomplished except by a similar method to that which I have used, in which the resistance and self-induction are separately measured and balanced, and by the use of an exceedingly rapid and sensitive instrument of observation, as the telephone, in place of the sluggish galvanometers, no matter of what construction.

The speed of telegraph instruments is greatly influenced by the resistance of the wire. I said in 1883§ that a great difference would be found in the resistance of an electrical conductor if measured during the variable instead of the stable period, and I have made numerous experiments with a view of ascertaining to what extent this difference would probably be felt on telegraph lines.

I have already mentioned that the time or the duration of the extra currents increases rapidly with the section of the conductor; consequently comparisons can only be made between wires of similar section for speed, or wires of similar resistance for differences in their variable period.

In measuring the resistance of a wire during the two periods, I have found it best to avoid the use of resistance coils, the simplest method being to measure or balance a given length of wire in one period, and then observing how much lengthening or shortening of the wire would produce a similar zero in the second period. Suppose that we commence by balancing the resistance during the variable period, and fix the sliding communications at the point at which we have obtained a perfect zero; we can now change to the stable period by means of the commutator; and as we no longer find a zero, but extremely loud sounds, we gradually lengthen the wire under observation until we have again a perfect zero. The amount of wire added to its previous length shows the difference in resistance between a conductor in which there are rapid electrical changes and that wherein the flow of current is constant.

Amongst numerous experiments I will cite a single example. I measured or balanced the resistance of of an ordinary soft iron wire, 1 metre in length and 4 mm. diameter, during the variable period, and found that it required in the stable period exactly 2 metres 58 cm. to balance the previous resistance. Similar tests on a sample of best charcoal iron wire, as used on our telegraph lines, gave still more remarkable results, showing 225 per cent. difference between the two periods; for 1 metre of this wire had, during the rise and fall of the current, precisely the same resistance as 3 metres 25 cm. in the stable period. This shows that an iron telegraph wire has with rapid currents *more than three times* the resistance during its actual work than that supposed to be its true resistance.

It was difficult on short lengths to find any change whatever in the resistance of copper or stranded iron wires in the two periods; the time of discharge being excessively rapid, I could only estimate the resistance by the electromotive force of the extra currents, or by forming the wires into coils (when a remarkably great difference is shown), and then estimating the proportional amount due to its own reaction; by this method I was enabled to detect 10 per cent. difference for a solid copper wire, and but 8 per cent. for the stranded rope of 36 iron wires. The difference in time of the duration of the extra currents between solid iron and copper and between solid iron and stranded iron is so great that we may consider a solid iron wire to belong, comparatively speaking, to the class of slow conductors, whilst copper and stranded iron would belong to the rapid.

I have shown a difference of resistance in the variable period between copper and iron of at least 200 per cent.—a difference which will be felt on instruments depending upon rapid changes, such as the telephone; and it is evident that the more rapid the contacts of a telegraph instrument the greater will be the difference between copper and iron. There is consequently a great electrical advantage in those instruments which require only a single current for each letter, as the economy of electrical impulses allows them to work at a comparatively high speed; the duration of the extra currents would be shorter than the length of their contacts, and consequently they would perceive very little, if any, difference between the two periods, or between iron and copper. If we use three or five currents for each letter, we must necessarily send them faster or closer together; and the difficulty increases in a rapid ratio with the speed of intermittent or reversed currents, until a point is reached (as I have shown in the case of best charcoal iron) where, whilst nominally working through 500 miles, we are practically working through an equivalent resistance of at least 1,500 miles, and this without taking into account the static charge, which would, in addition, from its comparatively extreme slowness of charge and discharge, cause the apparent resistance of the wire in the variable period to be much greater than I have mentioned.

In Mr. Preece's experiments he finds a difference of speed of 12·9 per cent. between iron and copper, which is far less than the difference of resistance during the variable period which I have obtained; and this may be explained by assuming that the speed of the reversed currents which he employed was only near the border land of extra currents. I am convinced that if Mr. Preece could have increased the speed of the instruments he would have found a far greater difference between iron and copper; and if I regard the results of a solid iron wire alone, I should consider iron as unsuitable for telegraph instruments requiring extremely rapid currents. Copper would reign supreme if it were not for the fact, which I have discovered, that stranded iron wires have even a greater rapidity of action than copper.

PHYSICAL CHANGES IN THE CONDUCTOR.

Self-induction not only depends on the nature and form of its conductor, but also on the physical state of the metal, as already shown in the case of soft and hard iron. I felt convinced that the higher force in iron was due to its magnetic capacity, and to prove this I tried the effect of heating the wire to a bright red heat, or 1,000° Cent. It is well known that iron loses its magnetic properties at bright red heat, and I found that its self-induction then fell to less than that of copper. This would have been conclusive had it not been for the fact that a different result takes place when the capacity of the iron for self-induction has already been reduced, as in the case of thin flat sheets of iron: in this case there is no disappearance or further decrease of induction except that due to the extra resistance caused by the increased temperature of the strip. Now, as the strip was highly magnetic when cold, and lost this property at red heat, there should have been some change in its self-induction if this were due to the magnetic nature of the iron alone. This requires further researches before a probable explanation can be given.

Iron is peculiarly sensitive to all physical changes. Mechanical strain of all kinds hardens the wire, and its influence on its

* British Association, Aberdeen, September, 1885.
† Discussion on the paper of W. H. Preece on Electrical Conductors, *Proc. Inst. Civil Engineers*, vol. lxxv., 1883.

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self-induction can at once be detected. An iron wire under a moderate longitudinal strain loses 40 per cent., and its capacity is then less than unstrained cast steel.

Iron well annealed has much less resistance than the same iron when hard drawn, and soft iron is generally employed for telegraph lines; but during the variable period a curious reversal takes place, as then soft iron has a higher resistance than hard iron. This apparent anomaly is easily explained if we compare the far higher self-induction of soft iron. Work is done at the expense of electrical energy, and the apparent higher resistance is due to the greater electro-magnetic action in soft iron.

An iron wire shows traces of remaining circular magnetism after the passage of a continuous current, reducing the following extra currents 10 per cent.

Magnetising the wire, or subjecting it to mechanical vibrations, when used separately, produce no apparent change in its inductive capacity, but a remarkable change takes place if either of these is used in conjunction with a constant current. Let us pass a constant current and heat the wire to red heat, allowing it to cool with the current on; or, in place of heat, magnetise the wire; or, in place of magnetism, give the wire mechanical vibrations: the result of either of these being a strong internal circular magnetism, due, I believe, to the loosening of the magnetic molecules, allowing them to rotate with greater freedom under the influence of heat, mechanical vibrations, or magnetism. A wire thus treated has no longer its previous self-induction, which has fallen 60 per cent.; and as the circular magnetism becomes fixed when the vibrations cease, this molecular structure remains a constant as long as we employ intermittent currents in the same direction, but the structure disappears the instant a reverse current is sent; and this explains why we have more than double the amount of self-induction from reverse currents, as each reversal destroys any remaining magnetism due to the previous passage of the current.

If we compare the electromotive force of self-induction on a given length of wire with the secondary currents generated in a second but independent circuit, we find that the self-induction is the most powerful, the secondary currents generated in a close independent copper wire being 20 per cent. less than its own wire. There is no difference between the self-induction of a current and the secondary currents; they are, in fact, as proved by Faraday, part of the same phenomenon. The self-induction is evidently due to the electro-magnetic reactions of the primary current, and as magnetism permeates space, the separation of the wires only serves to insulate the primary, but does not affect its magnetic, influence; and, as I have shown in the reactions of contiguous portions of the same current, so the magnetic reactions perpendicular to the axis of the current continue through the wire to all surrounding wires; and if we call the currents in the independent wire secondary, they are still secondary whilst enclosed in the wire of the primary; and as the reaction will ever be the strongest in the axis of the current, so will these currents be necessarily stronger than those induced in independent wires. For this reason we should be able to obtain extra-currents of far higher electromotive force than would be possible from a secondary wire of the same length.

It was my intention, on the reading of this paper, to demonstrate by practical experiments some remarkable properties of extra currents of high electromotive force; but I find that the subject and apparatus employed require a longer description than the limits of this paper allow. I must also leave aside for the present my experiments upon coils of different forms with cores of different metals. These, as well as other results obtained, indicate that there is a large field of useful research in many directions, each, however, requiring special studies according to the object we may have in view.

The record of numerous experiments, of which this paper is only an abstract, shows that the nature of the metal as well as its physical condition has an important influence upon the self-induction of an electric current, and by a study of the reactions produced by the contiguous portions of a current, and by application of the results, we may, as in the case of iron, transform an extremely slow conductor into one of the greatest rapidity; I therefore hope not only that these researches may be of interest from a scientific point of view, but that the results obtained may be of practical utility in some of the numerous applications of electricity.

The meeting then adjourned.

Physical Society, January 23rd.

Prof. GUTHRIE, President, in the Chair.

THE following communications were read:—"A note on the paper by Prof. W. Ramsay and Dr. S. Young, on some Thermodynamical Relations," by Prof. W. E. AYRTON and Prof. JOHN PERRY. The authors, after referring in the highest terms to the careful experimental work of Messrs. Ramsay and Young in their investigation upon "Some Thermodynamical Relations," the results of which were communicated to the Society at the last meeting, show that the four laws stated in their paper are in reality only one, since if any one of them is assumed the remaining three may be deduced from it. Hence it is sufficient to examine only one, and of the four the third is in the form that can be most readily tested. This law, the statement of which is, that for all substances at any given pressure the product $t\frac{dp}{dt}$ is constant, p being the pressure and t the absolute temperature of saturated vapour at that pressure, is represented mathematically thus—

$$t\frac{dp}{dt} = \phi(p) \qquad (1)$$

$\phi(p)$ being a function of the pressure, independent of the substance. Writing this equation

$$\frac{dp}{\phi(p)} = \frac{dt}{t}$$

and integrating, we get

$$t = a\,\psi(p) \qquad (2)$$

$\psi(p)$ being also a function of the pressure only, and a a constant depending only upon the substance employed. It is in this form that the authors have examined the third law; if true, it follows at once from (2) that the ratio of the temperatures of two saturated vapours to one another at any pressure is the same as the ratio at any other pressure. It is seen, however, either by reference to Regnault's numbers, or Rankine's formula

$$\log. p = d - \frac{\beta}{t} - \frac{\gamma}{t^2}$$

an expression based upon his molecular theory, and which, as remarked by one of the authors at the last meeting, agrees with Regnault's results with remarkable closeness, that this ratio is far from constant. The authors are therefore compelled to conclude that the expressions given by Prof. Ramsay and Dr. Young must not be regarded as absolute laws.

"A note on the paper by Prof. J. W. Clarke, On the Determination of the Heat-capacity of a Thermometer," by Mr. A. W. CLAYDEN. The author has applied a correction to an expression given by the late Prof. J. W. Clarke for measuring the heat-capacity of a thermometer, in a paper communicated to the Society at a previous meeting (April 25th, 1885). Prof. Clarke's expression was affected by the mercury not entirely filling the bulb and stem of the thermometer. The corrected expression obtained by the author is

$$v_1 = \frac{v(s - s_2)}{s_1 - \frac{s_2(1+\beta t)}{1+\alpha t}}$$

s, s_1, and s_2 being the mean densities of the instrument, mercury and glass respectively; β and α the co-efficients of voluminal expansion of mercury and glass; v and v_1 the volumes of the instrument and of the mercury.

"Note on Some Organic Substances of High Refractive Power," by Mr. H. G. MADAN. In the course of some correspondence respecting M. Bertrand's polarising prisms, the author was informed that the cement used was napthyl-phenyl-ketone dibromide. He has consequently prepared specimens of the ketone and subjected them to optical examination. The ketone is a thick yellow oil, boiling at a temperature near the boiling point of mercury; it appears to be a very stable, neutral, and harmless substance like Canada balsam, but, unfortunately, it does not appear to be capable of hardening, and hence it is not by itself adapted for a cement. Its refractive index for the D line is 1·666, higher than that of carbonic sulphide, while its dispersive power is approximately the same as that of that substance. The author has made the bromide of the ketone referred to above, but it seems liable to decompose, with formation of hydro-bromic acid, which acts upon the spar. Mr. Madan also exhibited a specimen of metacinnamene, a highly refracting glass-like solid obtained by the action of light or heat upon cinnamene. This substance possesses a refractive index of 1·593 for the D line and would make a valuable cement if it showed a firm adhesiveness for glass.

The PRESIDENT exhibited and described an instrument he had made in the course of an acoustical investigation upon which he had been engaged. It is a musical instrument similar in principle to the harmonicon. In the case of the harmonicon the rectangular plate is usually supported by strings passing through the nodes, but the author wished to make an instrument that could be "bowed." The "nodes" are not absolute positions of rest, the particles at them describing curves having cusps pointing outwards. The plan adopted was to solder two springs to the plate, which was of brass, the points of attachment being slightly outside the nodes, and the springs being such as to give the same fundamental note as the plate. The other ends of the springs were attached to the mouth of a resonator whose fundamental note was also that of the plate. The plate when struck or bowed gave a tone very like that of a tuning fork; and in a discussion that followed,

Prof. S. P. THOMPSON suggested the possible use of these instruments as a substitute for a series of forks, the cost of a complete set of which often places them beyond the reach of the student.

Prof. McLEOD suggested that the springs should be tuned to the octave of the plate instead of to its fundamental, and that they should have a slightly different form.

NEW PATENTS—1886.

893. "Supports or holders for incandescent electric lamps." A. SWAN. Dated January 20.

932. "Dynamo-electric machines." A. LE N. FOSTER, F. V. ANDERSEN. Dated January 21. (*Complete.*)

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955. "Electric plug switches." C. HALL, H. C. HAROLD. Dated January 21.

956. "Lanterns for directing the light of ordinary electric arc lamps horizontally." C. HALL, H. C. HAROLD. Dated January 21.

958. "Means for preventing the falling of broken telephone, telegraph or like overhead wires." F. C. FREEMAN. Dated January 21.

973. "Switch to control one incandescent electric light." T. and H. BAYLEY. Dated January 22.

974. "Economic bell battery." A. ALLMARK. Dated January 22.

993. "Combination of an electric alarm bell attachment to a hook or peg or hooks or pegs used for hanging or suspending goods, &c." S. P. WESTON. Dated January 22.

997. "Acoustic or mechanical telephones." CORDNER, ALLEN AND CO., T. M. COLLET, H. COLLET, G. L. ANDERS. Dated January 22. (*Complete.*)

1011. "Construction or arrangement of dry electric battery with regenerative and self-sustaining power." A. RETTICH. Dated January 22.

1028. "Telephone receiver with movable armatures." E. H. ANDREOLI. (Communicated by J. Boisselot.) Dated January 23.

1034. "Electrical conductors." G. SUTTON, HENLEY'S TELEGRAPH WORKS COMPANY. Dated January 23.

1044. "Constructing and fitting electrical insulators." J. E. GRIFFITH. Dated January 23.

1054. "Construction or formation of plates with composition for electric batteries." J. H. NOAD, R. MATTHEWS. Dated January 23.

1067. "Galvanic batteries." T. CAINK. Dated January 25.

1096. "Incandescing electric lamps, and systems of electric lighting." B. J. B. MILLS. (Communicated by L. Stieringer.) Dated January 25.

1099. "Mechanical telephones." O. SHINNER. Dated January 25.

1125. "Distributing electricity by means of secondary generators or transformers." W. H. SNELL. Dated January 26.

1150. "Electro-dynamic motors." T. J. HANDFORD. (Communicated by F. J. Sprague.) Dated January 26.

1151. "Galvanic batteries." W. W. POPPLEWELL. (Communicated by F. La O. Lathrop, J. W. Carter and C. Faber.) Dated January 26. (*Complete.*)

1160. "Smelting ores by electricity." W. P. THOMPSON. (Communicated by A. H. Cowles.) Dated January 26. (*Complete.*)

1192. "Insulating stands." O. E. WOODHOUSE, F. L. RAWSON. Dated January 26.

1193. "Incandescent electric lamps." O. E. WOODHOUSE, F. L. RAWSON. Dated January 26.

1196. "Actuating mechanism for electro-static generators and applications thereof." J. G. LORRAIN. Dated January 26.

1197. "Electric street fire-alarm." F. E. STUART. Dated January 27.

1220. "Electric clocks." J. CASSEY, J. F. DIXON. Dated January 27.

1246. "Thermo electric piles." R. F. VENNER. Dated January 27.

1250. "Electrical contact apparatus." C. O. VARLEY. Dated January 27.

1277. "Utilising and applying clockwork as a motive power for machines for generating electricity." G. SAUZE. Dated January 28.

1284. "Regulation and control of the electrical currents from secondary generators." J. A. KINGDON. Dated January 28.

1292. "Telephones." H. EDMUNDS. (Partly communicated by S. Thornberry.) Dated January 28. (*Complete.*)

1309. "Resistance boxes and like apparatus for use in electrical circuits of any kind." G. A. NUSSBAUM. Dated January 29.

1310. "Telephone transmitters." W. P. THOMPSON. (Communicated by E. J. Gilliland.) Dated January 29. (*Complete.*)

1313. "Incandescent lamp holders." W. A. S. BENSON. Dated January 29.

1320. "Secondary batteries." A. RECKENZAUN. Dated January 29.

1322. "Portable electric burglar alarms." L. C. DETTMER. Dated January 29.

1337. "Electrical switches." F. L. RAWSON, J. H. DAVIES. Dated January 29.

1340. "Dynamo-electric machines." G. C. FRICKER. Dated January 29.

1354. "Electrode for secondary batteries." H. J. ALLISON. (Communicated by E. M. Gardner.) Dated January 30. (*Complete.*)

1375. "Galvanic batteries." R. M. BAILY, A. GRUNDY. Dated January 30.

1382. "Clearing ships' telegraph cables." H. J. ECK, E. A. WOOD. Dated January 30.

1410. "Incandescent electric lamps." C. BAKE. Dated January 30.

1415. "Primary and secondary electric batteries." N. J. CONTARINI, T. WRIGLEY. Dated February 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

562. "Improvements in connection with telegraph, signal, and like poles or standards, for steadying and retaining them in position." W. B. INCLEDON. Dated January 15. 8d. Consists in combining with that portion of the pole, or its equivalent beneath the earth, a steadying plate formed and attached in novel manner. The said plate has two parallel surfaces in different planes, connected by a curved or bent portion, through which, and the post or its equivalent, bolts are passed at right or other angles to each other, so as to firmly secure the plate and pole together, in whatever direction strains may be caused to act on them.

1701. "Improvements in dynamo-electric machines." M. H. SMITH. Dated February 7. 11d. Comprises two "horse shoe" or bridge shaped electro-magnets, so placed and wound that the south pole of one magnet is opposite the north pole of the other, making two separate magnetic fields, in which two separate armatures revolve attached to a spindle, passed through them, having the commutators in the middle or between the armatures, the bearings or journals of the spindle being at the outside.

1785. "Improvements in apparatus for lighting railway carriages by electricity." A. M. CLARK. (Communicated from abroad by the Maschinenfabrik Esslingen and the Electrotechnische Fabrik Cannstatt, of Germany.) Dated February 9. 1s. 3d. Has for its object the lighting of railway trains or single carriages, whether travelling or stationary, by the incandescent electric light, one or more dynamo-electric machines and one or more accumulators being employed.

CORRESPONDENCE.

The Dynamo as a Generator and as a Motor.

Kindly allow me space for a few lines rendered necessary by the references in your issue of January 22nd to my paper on the above subject.

I am glad to see from Mr. Brain's interesting letter that his experience accords so completely with the principles and view indicated in the paper. With regard to the question of the efficiency of electric motors, I wish to point out that the tabulated figures given in my paper are not to be taken as indicating a low efficiency. An unascertained loss in transmission was *not included* in the horse-power readings, and should, therefore, be added to them. By a clerical error this unascertained loss is stated to be *included* in the horse-power column. As a matter of fact, other experiments show that the commercial efficiency of the "Victoria" motors (or the ratio of the power delivered in a useful form at the pulley, to that absorbed at the terminals) is over 80 per cent. with full load.

In the remarks which you quote from M. Hospitalier's article, a reference is made to the use of motors without iron in the armatures. Of course I am aware—and sufficiently indicated in the paper—that iron is no more a necessity in the armature of a motor than in that of a generator. The almost universal practice, however, shows that its use is attended with great practical advantage from a structural point of view.

I am glad to say that since writing the paper I have seen reason to considerably modify the view therein expressed as to the amount of the effect produced by the difference of the character of the induction of eddy currents in generators and motors. The difference will probably not be found of such importance as to furnish a very strong argument against the use of iron in the armatures of the latter.

W. M. Mordey.

Blue Photos from Tracings.

Some three months ago Mr. Hett asked in your columns whether it is practicable to print blue photos with a single glow lamp.

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We make constant use of this process, and find that in such weather as this, when it takes all day to produce even a faint impression, we can get a capital print in ten minutes at 10 inches from a 25 ampère arc.

The actual candle-power is probably about 1,600 C.P., as the carbons were not set for a condensed beam (nominal 6,000 ?). A 20-candle glow lamp would require 12 to 14 hours to do the same even if it were of the same actinic power. But it is not, and it would probably take 60 to 80 hours.

Alex. P. Trotter.

Dynamos.

I feel it necessary to say a few words in reply to the remarks of Mr. Crompton and Mr. S. Walker. It is in no way my desire to make an attack on dynamo makers. My wish is to point out that competition carried too far is to the disadvantage of the purchaser who, in most cases, has but little knowledge of electricity.

What Mr. Crompton says of the first machine supplied to me is true, but it was sent knowing what it had to do, and for this reason the exchange was made, having failed. In speaking of running cool, I refer to the shunt. The two Crompton and two Siemens machines all get very warm, but not dangerously hot; still this should not be so, it is so much loss of power, and it cannot be an advantage apart from this. The cost of the large Elwell-Parker machine, I believe, to the public is less than the dynamo supplied to me by Messrs. Crompton, so clearly on this head there is an advantage.

It is right to state what the total requirements here are:—For house, stable and engine house, 100 ampères at 110 volts: for workshop the same. Hence 200 ampères are required at the maximum and the Crompton machine was set up to do half the work, and the large Siemens to do the other half. The Elwell-Parker dynamo, I believe, will do the two put together and forms a reserve. The reason for ordering all dynamos to give 130 volts is, that I require this E.M.F. for charging the cells when giving 35 to 40 ampères, and in consequence of the falling curve of simple shunt machines; the advantage I gain is that the dynamo may run far slower than intended by the manufacturer. The plan is a good one, for I have rarely found a maker keep within the speed specified. Here is a case. The new Crompton dynamo is now in its place and has been running a few days. The specified speed was under 600 revs. per minute for 130 volts. By test 630 were required. Ampères maximum 125. For 40 ampères I find the E.M.F. about 140 to 145 volts, so I have lowered the speed to 580. Then, again, if cells are ever made which may be charged more rapidly, the speed can always be raised, which would not hold good if used at the maximum speed in the first instance. Judging by the size of the wire on the Crompton dynamo as compared with the Elwell-Parker, I should not be afraid of taking 250 ampères from the latter for many hours together.

Mr. Walker asks what is the commercial efficiency of the Elwell-Parker machine? It can be answered thus. The loss in the armature is very small indeed, and the shunt current, during tests made, was 3·5 ampères. After taking the first 40 ampères from this machine, I found for all increase of current in the *outer circuit*, 1·1 I.H.P. gave 1 E.H.P. as nearly as possible, so that 90 per cent. approximate is the reply. I am making a number of tests with this machine and the Crompton and will publish the results when completed, and give the methods employed to permit of criticism. Mr. Walker appears to enquire whether my saving of 14s. a week is supplemented by some other outlay. The answer is *no*. The idea of a standard testing laboratory is good, and I shall rest satisfied if my communication does no more than cause such a movement to be set on foot. Before concluding, I must thank both your correspondents for the friendly spirit which they have shown, and it is right to add that I have been able to place three of Mr. Crompton's machines in installations, in order to show your readers that I am no enemy of them, but I wish to see these machines perfected.

David Salomons.

Broomhill, Tunbridge Wells,
February 1st, 1886.

Without making any statements regarding the maximum capacity of the Elwell-Parker dynamo referred to by Mr. Crompton, which, coming from an interested individual, might not be considered of the highest value, I hasten to say, in reply to the good suggestion and substantial offer made by him, that Messrs. Elwell-Parker would hail with the greatest pleasure any public trials of dynamos, and would willingly contribute towards the expense of carrying them out in a thoroughly satisfactory manner.

My great regret is that such tests were not made two years ago, when some manufacturers were much farther behind than they now are.

P. Bedford Elwell.

8, Wilton Place, S.W.,
February 3rd, 1886.

Telephone Patents.

Allow me to point out that the quashing of the "Bell" patent in this country, should it occur, would have little or no effect on the present telephone monopoly, as it is the "Edison" and not the Bell patent that at present bars the way to telephonic extension.

While on this subject, I may mention that I observe from a contemporary that the United Telephone Company are about to proceed against a Liverpool gentleman for infringement on account of his having used the Silvanus Thompson instruments of the "New" Telephone Company.

It appears to me that it is rather a hole-and-corner proceeding to take action against a private individual instead of acting direct, and sueing the manufacturers themselves.

"Telephonist."

Efficiency per Pound of Copper.

Mr. Sidney F. Walker, in his interesting letter which appeared in your last issue, omitted, I think, one very important fact when writing on the above subject. If we wish to get such a thing as efficiency per pound of copper in our dynamos, we must use only the softest and purest quality of iron in the field-magnets and armature or, in other words, we must use iron of small coercive force. It appears to me, however, that this term efficiency per pound of copper, is not only uncalled for, but is quite misleading; and I agree with what Mr. Walker says or aims at in his letter, viz., that a machine ought to be judged according to its commercial value.

When a man wants to buy a dynamo he asks, "How much does it cost? What will it do? How much power does it require to drive it? What maintenance does it require? How long will it last? Is it thoroughly practicable and reliable? Does it require much attention?" and such like questions. Imagine a dynamo maker replying as follows:—

"In reply to your enquiries I beg to say that my machines may perhaps be a little more expensive than those of other makers, and may require a little more power to drive it, in order to work the requisite number of lamps. It may also require more attention than some other machines; but all these slight defects are fully compensated for, as my machine has a *greater efficiency per pound of copper* than any other machine in the market."

Where do your readers think such a letter would go? Why, in the waste-paper basket, of course.

Charles Lever.

Bowdon, Cheshire.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 429.

WOODHOUSE AND RAWSON LAMPS IN THE PHILADELPHIA TESTS.

A MONTH or so ago we published a letter from Messrs. Woodhouse and Rawson relative to the tests of incandescent lamps of their manufacture by a Committee of the Franklin Institute, Philadelphia. We then gave it as our opinion that they were ill-advised in taking the action they did, as, had they attentively perused our columns they would not have remained in ignorance of the proceedings in Philadelphia, as they claim to have done, and would have seen that the circumstances under which their lamps were included in the tests were fully explained in the committee's report. The attention of the President of the Franklin Institute, Mr. W. P. Tatham, has been attracted to Messrs. Woodhouse and Rawson's letter, which was communicated to other journals besides our own, and he has written at some length in a contemporary in refutation of their assertions. Mr. Tatham's letter, we may remark, fully corroborates every statement we made at the time, and clearly shows that no cause for the complaint existed, so far as the Franklin Institute was concerned.

Messrs. Woodhouse and Rawson complained, first, that their lamps were tested without their knowledge or consent, and, second, that their lamps were run at five volts above what they were labelled. Mr. Tatham gives the following account of the manner of receiving the lamps, and the treatment which they received:—

"Two lots of their lamps were tested. The first lot, selected at random from a barrel of lamps belonging to the Van Depoele Company, were labelled 20 candles, 55 volts. They were tested and run at 55 volts. No. 9, with resistance cold of 106 ohms, lived longest, 715½ hours. No. 2, resistance cold 102 ohms, exhibited phenomenal brilliancy. The complaint that this lot of lamps was entered without their knowledge or consent may be well founded. The second lot of lamps was received through the Edison Company. I now learn that the origin of this transaction was as follows:—At a meeting of the London Society of Arts, held December 3rd, 1884, Mr. Wm. H. Preece, F.R.S., read a paper upon 'Electric Illumination,' in which appeared the following language (see *Journal* of the Society of Arts, December 5th, 1884, page 73):—'The efficiency of the glow lamps has also been very considerably affected by the improvement made, for instance, by Messrs. Woodhouse and Rawson and by Mr. Bernstein. The efficiency of the Edison lamps means the consumption of energy at the rate of five watts per candle, but lamps are now being made which give an efficiency of two and a-half watts per candle with an equal life, which is equivalent to an immediate reduction of 50 per cent. in the amount of energy required to maintain the system alight, and therefore in the cost of production. Whereupon the Edison Company challenged Mr. Preece to produce such lamps and have them tested by the Franklin Institute, whose committee was preparing for the tests which afterwards were made. Mr. Preece procured the lamps and forwarded them to the Edison Company, whose letter dated April 13th, 1885, to Prof. Marks (who acted as an executive committee), says:—'Mr. Preece, the electrician of the English Post Office, has sent to Mr. Edison a number of Woodhouse and Rawson lamps. They are now in the New York Custom House. We have given directions to have them forwarded to you at the Electrical Exhibition in the original packing as soon as they are appraised.' At that time our test boxes were all occupied and our current employed. Inside of the box, when received, was found a large label addressed 'for Mr. Wm. H. Preece, 20 candles, 50 volts.' The usual label of Woodhouse and Rawson was on every lamp, altered, however, so as to read as above, the figure 0 in the number 50 being written over an erasure. The resistances cold of all the lamps tested were nearly uniform, five at 100 ohms; two, each 99 and 101 ohms, and one 102 ohms. [See Report, Table VI., page 38.] These circumstances persuaded us that the lamps were not selected by chance."

With regard to the second point of Messrs. Woodhouse and Rawson's complaint, Mr. Tatham says that upon discussing the preliminary results the judges found it impossible to follow the label. Twenty candles illumination could not be had with 50 volts; and they decided to raise the electromotive force. The preliminary tests showed the lamps to be both dim and dear when tested with 50 volts, and as to their duration, the remaining time of the tests, about 300 hours, would furnish no proof. Thus, it will be seen, it was out of consideration for the makers of the lamps that the judges raised the electromotive force and refrained from publishing a full statement of the preliminary test with the 50 volts.

ALTERNATING CURRENTS AND THEIR PART IN ELECTROTECHNICS.*

By MAX DERI.

INDUCTION is one of the most important physical phenomena of which we avail ourselves in electrotechnics. With induction is most closely connected the so-called intermittent current, and, as the result of continued action, also alternating currents.

From this fact I draw the conclusion, for which I will offer reasons in the course of this paper, that alternating currents are not only destined to play a most important part in electrotechnics, but that they already fulfil requirements far more important than many people imagine.

I know that in this country there exists, even amongst some of our professional colleagues, a kind of antipathy to, or rather a vague shyness of, alternating currents. I have often heard myself the hesitating objection, "Yes, but alternating currents. . . . ." When I made enquiry into the nature of the objection, I received either a very unsatisfactory answer or no answer at all.

I repeat that this shyness exists in this country only; in other countries, where electrotechnics progress as rapidly as with us, it is scarcely known. In order to substantiate this, I mention, as an instance, that our fellow member, Mr. Zipernowski, made this year (1885) a tour through Western Europe with the view of interesting professional circles in an invention exclusively based on the application of the alternate

* A paper read before the Elektrotechnische Verein, in Vienna, on the 18th of December, 1885.

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currents. He did, no doubt, meet with many objections and adverse criticisms, but on no occasion was the invention objected to on account of its using alternating currents. No one evinced the least dread of that. Such electricians as have gained with us a considerable reputation in their application of the continuous currents took a keen interest in the invention, and strove zealously to promote its exploitation.

What, then, is there to be dreaded? What is the cause of that prejudice against alternating currents which obtains in our country?

It is asserted by many that alternating currents are dangerous and not economical; that is, that they have little useful effect, both in the way they are generated and applied.

What the origin of those accusations is will be made evident by a rapid retrospect of the history of the development of the electric currents. You will see how easily mere appearances may lead us into error.

At first battery currents—that is continuous currents—only were known. Those currents could be handled without danger, as their tension was comparatively low. How, indeed, would it have been possible to set up by means of elements electromotive forces of several hundreds or thousands of volts, when it was quite a difficult problem to produce the 50—60 volts required for an arc light. For an arc light quite a respectable army of elements, a battery which filled up a whole room, was requisite.

Later on, after the discovery of induction, when the physiological actions of the current became known, that very same induction was used for the generation of higher electromotive forces. The battery currents, whose tension was so low that they had no effect at all on the nerves, were transformed into currents of higher tension which were able to shock the nervous system. Those currents were either the so-called extra currents, or the secondary currents produced by Ruhmkorff's coil. The currents of higher tension were then always induction currents; and induction generates nothing but *alternating currents.*

Currents of higher tension were then generated for the purpose of acting on the human organism; and because those currents invariably happened to be—in virtue of the manner in which they were generated—alternating currents, what was more natural than that with the notion of alternating currents that of danger was associated. The delusion was so easy. It was known that a current from 10 elements did not irritate the body at all, but that current being connected to an induction apparatus, each interruption of the current caused pain. The conclusion was, therefore, a continuous current is harmless, each interruption current hurts, therefore alternate currents are dangerous.

You are all aware that this is a great delusion. Let us make the following experiment:—If we close a battery of a few elements in such a manner that no self-induction can occur, for instance, by a wire or by incandescence lamps, &c., we can interrupt such a circuit a hundred times slowly or rapidly, and no action will be observed; but if we close the same battery by a conductor of considerable self-induction, for instance by a bobbin with many windings containing an iron core, each interruption will be made painfully manifest. Now, we have seen that the interruption of one and the same current was in the first case without effect, but that it exhibited in the second case a very powerful action. Why is this so? Because the interruption itself has no effect, but it is the current that is set up by the induction at the moment of the interruption which has the power to irritate the nerves if it only possesses the requisite tension. But such an induction current was not present in the first case, whereas in the second case a current was produced, which was so violent in its action, because its electromotive force was much higher than that of the original battery current itself.

I will illustrate this with an example, perhaps more familiar to you. Let us take a dynamo machine with powerful magnetic fields, an Edison machine, for instance. The field magnet cores are wound with copper wires of extraordinary length, and those coils are, as you know, joined to the pole terminals of the machine so that they may form a branch circuit. The difference of potential at the terminals is about 100 volts, the field magnet coils consequently receive only 100 volts. No one needs to be afraid to touch the ends of those coils with naked hands, for it is well known that a difference of potential of 100 volts is harmless. But let, on the contrary, everybody beware of touching those ends at the moment that the circuit formed by the coils is suddenly interrupted. In consequence of the sudden demagnetisation of the iron a momentary current is set up in the coils, whose tension may amount to several hundred volts. But if we interrupt the external circuit, which is formed by incandescence lamps, we shall scarcely feel that interruption, although a current of 100 volts is interrupted there also.

A trial of only a second's duration is sufficient in the first case to cause the imprudent experimenter to stagger; whilst, in the second case, the interruptions may be continued for hours as rapidly as possible without the least danger of shaking the nerves.

Thus you see that it is not the change of direction of the current, nor its duration, but solely its tension which causes the danger.

But there were other accidental circumstances which tended still more to confirm that erroneous idea. You will recollect the invention (about eight years ago) of the so-called "subdivision of the electric light," that is, the possibility of feeding several arc lights in one series by one dynamo machine. First of all we had the Jablochkoff candles for which Lontin and Gramme designed their alternate current machines, and, afterwards, Siemens lamps, which were fed by his alternate current machines. No other machines were at that time better suited to that purpose. Thus were, for the first time, currents of higher tension introduced into electric lighting: then was heard, for the first time, the caution: Take care! it is dangerous to touch the conductors, &c.; and as those high tension currents chanced to be alternate currents, it was again believed that those currents only were dangerous. No attention was paid to the fact that the continuous current machines of Brush with their 1,000—2,000 volts, which were introduced soon after, were far more dangerous than the alternate currents.

It was likewise an error to consider the physiological action of a current proportional to its quantity. If we touch one or two points of a conductor, the quantity of current circulating in that conductor is immaterial; that current only which passes through the body is effective. If we touch two points whose difference of potential is 100 volts, the action on our organism is the same whether 1 ampère or 1,000 ampères circulate. Our body offers a certain resistance between the two points touched, therefore the current passing through it is equal to the quotient of the difference of potential, 100, divided by the resistance of the body. This value, which represents the physiological action of the current only, is, therefore, totally independent of the quantity of current flowing through the circuit.

If we wish to judge of the danger of a circuit, we must determine the maximum difference of potential which can ever occur, or may possibly occur, between any two accessible points of the conductor. Suppose, for instance, we join up many lamps in series, as in the case of arc lamps, or of the groups of incandescence lamps in Temesvar, each lamp, or group of lamps, will perhaps require 50 volts; between the terminals of that lamp or group of lamps there will therefore be a difference of potential of 50 volts. But if that circuit is interrupted at any point by a lamp, there will be a far higher tension at that point, namely of as many volts as the dynamo machine is capable of yielding for the whole series of lamps.

To resume: *it is the difference of potential between the points of the conductor touched by the body and not the duration or the direction of the currents in which the danger lies.*

Consequently, a current, whether continuous or intermittent, or alternating, can only be dangerous when it

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has a high tension, and each current is harmless when it has a low tension, say of 100 volts or less.

I hear some one make the remark that a difference between current and current—between continuous currents and alternating currents—must exist in any case. That is correct; a difference does exist. It is as follows:—

The tension of a continuous current is a value which remains unchanged during a finite period, but the tension of an alternate current is only a mean value, as is shown by the instrument, which is unable to follow the extraordinarily rapid reversals of the current.

But if we consider the differences of potential in infinitely short spaces of time, we find, of course, that they are values which are greater, and, again, values which are less than the measurable value of the tension which qualifies the current.

The maxima are greater than the mean value, and, although for all the other actions of the alternating currents the latter value is effectual, in the case of the physiological action the maximum value prevails, as I pointed out before.

What proportion is there between maximum and mean value? It has been several times attempted to determine that proportion. Herr Uppenborn two years ago estimated the ratio at about 0·56 (I do not recollect the exact figures), that is, the maximum value is to the mean value as 100 : 56.

But I believe that there cannot be a fixed ratio, for it must depend on the form of the diagram, and I believe each dynamo machine has its own diagram. It is certain that the more perfect the induction the flatter will be the top of the diagram, and the nearer will be the mean value to the maximum.

It is further certain that the figures 0·56 can easily be exceeded, and that it would not be impossible for the proportion to come very near to 1 : 1.

So, then, my assertion that an alternating current of a low electromotive force, of 100 volts or less, is not dangerous is proved; but I must admit that, under conditions otherwise equal, the safety limit of the electromotive force of the alternating current must be held to be 20, 30, or 40 per cent. lower than in the case of a continuous current.

After what has been said, you will certainly agree with me that the sweeping assertion that all alternating currents are dangerous is a great injustice.

It is admitted that a current whose electromotive force never exceeds 200 volts harbours no danger. The English Parliament, no doubt advised by the most eminent experts, have recognised that fact. Therefore no one should feel any doubt that an alternate current of an electromotive force of, for instance, 100 volts is absolutely without danger.

In order to ensure safety it is essential that, in house conductors for electric current of any description, and in lamps which are attended to by unskilled persons, none but currents of low tension should circulate; and that such conductors as must necessarily convey currents of high tension should be inaccessible to the uninitiated. To experts there is, of course, little danger. We heard recently in this place a lecturer cite the following saying of Sir William Thomson: "A current of an electromotive force of several thousand volts in the workshop is less dangerous than a circular saw."

Many persons are of opinion that alternating currents cannot be generated by dynamo machines with the same useful effect as continuous currents. This opinion, in so far as it is intended to be general in its scope, is likewise founded on error, as I will now proceed to show. In order to enable me to do so, allow me to explain, from a practical point of view, the action of induction, which is the real cause of the alternating currents.

If a conductor, of which we consider a certain length only, is in that physical condition which we indicate figuratively by saying that when an electric current is flowing through it certain curves are formed in it, or magnetic lines of force circulate in the atmosphere immediately surrounding that conductor. If the conductor is surrounded by air only, that magnetic atmosphere is of but little extent, and the circulation of lines of force weak. The same is the case when most of the other substances known to us surround the conductor; but if that substance should be iron it is different. Iron offers much less resistance to the lines of force. It is a fact that the circulation is incomparably stronger in a piece of iron when brought near to the electric conductor than in other substances. The iron is then in that condition which we call magnetic, and magnetic poles are formed at those points where the lines of force enter the atmosphere, forming magnetic fields.

Is it necessary to do work, that is, to consume energy, in order to maintain the iron in its magnetic condition? Strictly speaking, No. By magnetising a mass of iron we produce no energy, we must therefore consume no energy for that purpose. On what does the intensity of the magnetic fields really depend? The magnetic condition is the more intense as the electric current in the conductor is the stronger, and the iron is the nearer to that current. But if we wish to consider not only the intensity but also the power of the magnetic fields, the length of the active conductor is a factor which must be taken into the account. We say, practically, the magnetism of a mass of iron is proportional to the product of the ampère turns, because, in practice, we actually wind the conductor closely around the iron.

The wire which forms the coil of the magnet core has, it is true, a certain resistance, and current energy is always converted into heat, in accordance with Joule's law $J^2 r$, but this is really nothing but a *practical necessity*.

But the case is different if we need not spare the material. We have produced with $J^2 r$ a certain magnetic intensity in a certain mass of iron, by causing the J-ampères to circulate in a spiral around the iron. If we increase both the length and the section of the wire of the coil tenfold, its resistance will remain unaltered. The same electromotive force will produce the same number of ampères, and the consumption of current energy, $J^2 r$, will remain the same. But, on the other hand, we have now ten times the number of ampère turns, and consequently produce in our mass of iron a magnetic-field ten times as powerful.

Thus we can with the same electrical energy produce a hundred, or a thousandfold the magnetism, and we may say that with an infinitely small electrical energy, infinitely powerful magnets can be made.

In practice, however, infinity does not exist; but for the terms infinitely small and infinitely great we may substitute extraordinarily small and extraordinarily great. Prof. von Waltenhofen has proved that for the magnetisation of a ton of iron to saturation, not more than 15 kilogrammemetres of effect are required.

In other words, magnetism is a force, but in itself not an energy-producer. In order to do work by means of continuous currents induced by magnetism, we must have the assistance of another factor, namely, motion. By means of motion we can multiply the small electrical energy which produced the magnetism; that is, we can by setting the magnetism in motion generate electric currents far more powerful than the exciting current. That is the fundamental principle of dynamo-electricity.

If we impart motion to a second conductor more or less parallel to the first conductor, so that it cuts the lines of force, an electric current will be produced in it. If we now close that conductor we can easily convince ourselves of the existence of the current, but that current only exists whilst the motion of the conductor across the lines of force continues.

And that is the dynamo-electric machine in its simplest form. It is immaterial whether the magnetic-field of the iron is permanent or produced by some source of electricity, or whether it is strengthened and maintained by the electric energy produced in the mass of iron itself.

Let us take a single turn of wire and move it within a magnetic-field. It will cut the lines of force. As long as the density of the lines of force within the

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turn remains unaltered, no resistance is offered to the motion of that turn and no current flows through it. But as soon as the magnetic intensity within the turns of wire increases or decreases, the motion is impeded and an electric current in one or the other direction is generated; if the turn is moved from a less intense to a more intense magnetic-field an electric current will flow in a certain direction, but if the turn passes from an intense to a less intense magnetic-field a current will flow in the opposite direction.

(*To be continued.*)

ON THE RUNNING DOWN OF BATTERIES AS INFLUENCED BY THEIR PERFORMANCE OF MECHANICAL WORK.

By Dr. OLIVER LODGE, in the *Engineer*.

ALTHOUGH there is nothing but what is perfectly well known in the relation between the running down of a battery and the amount of external work it is doing, yet, inasmuch as batteries are not unlikely to be more and more generally used as sources of mechanical power, it may be worth while to answer the question of the Cromer "Student" in your issue of 22nd January somewhat fully.

The correspondent describes an interesting model of an electric hammer driven by a battery, which does about 150 foot-pounds of work per minute, or has about the two-hundredth of a horse-power; and he then proceeds to say that whereas the books tell him that his battery should run down faster when the hammer is stationary than when it is at work, he finds no such result; and he implies, or at least it is not unnatural for him to think, that he would have expected the battery to run down faster while doing mechanical work than while not.

Now the first thing to thoroughly grasp is that the consumption of material in a battery is simply proportional to the strength of current flowing through it; provided, of course, all local action is avoided; it depends on the quantity of electricity transmitted, and on nothing else. The amount of zinc dissolved in every cell of a series battery per ampère hour is accurately known, and is 1·21 grammes.

Hence any cause which increases the strength of current hastens the running down of the battery; and any cause which opposes the current retards the consumption of material. Now the performance of mechanical work of whatever sort, by a current, necessarily sets up an opposition E.M.F. and weakens the current, as may be proved, and was proved by Helmholtz in 1847, as follows:—

Let E be the electromotive force of a battery, supposed constant; and let C be the current flowing round a circuit of total resistance, R, resistance also being supposed constant. Then, by definition of E.M.F., the "horse-power," or work done per minute by the current, is E C.

As the current flows round the circuit heat is generated, and this heat was found by Joule experimentally to equal $R C^2$ per unit of time.

Now if we first suppose that there is no working machine in the circuit—*i.e.*, no machine actually at work—stationary machines there may be as much as one pleases, and they may be holding up weights; but they must not be moving either in the way of raising or lowering them, neither must there be any chemical decomposition going on, or any form of activity other than that already considered in the battery; I say, given all these conditions, it follows, by the conservation of energy or the first law of thermo-dynamics, that

$$E\,C = R\,C^2 \qquad (1)$$

an equation which asserts, when we compare it with the Ohm's law definition of R $\left(R = \frac{\text{E.M.F.}}{\text{current}}\right)$, that throughout the circuit, under the supposed circumstances, there is no E.M.F., but E.

But now make another supposition: Suppose a working machine, or a decomposition cell, or some other form of activity, introduced into the circuit, whereby the current shall be made to do work—raising weights, for instance, or turning machinery—and let the horse-power of this machine be called P. Then no longer can we equate the power of the battery with the heat produced; we are compelled to take into account every form of energy which is being developed, mechanical or chemical as well as thermal, and so our equation becomes—

$$E\,C = R\,C^2 + P \qquad (2)$$

And if again we compare *this* with the Ohm's law definition of R $\left(R = \frac{\text{E.M.F.}}{C}\right)$ we find that E is no longer the sole or effective E.M.F. in the circuit, but that the total E.M.F. is $E - \frac{P}{C}$; that is, there is an opposition E.M.F., of strength $\frac{C}{P}$, and it is natural to consider this opposition E.M.F. as set up in and by the moving machine; or in and by the decomposition cell, if such it be that has been included in the circuit, in which latter case the opposition E.M.F. is known as polarisation. And be it noted that it matters not whether decomposition goes on in a special cell or in one of the battery cells—*wherever* it goes on it subtracts its full quota of E.M.F. from the current, and is equally well called polarisation.

It is plain then that, since by an active machine the total E.M.F. of the circuit is diminished while its resistance remains unaltered, it follows that the current must be weakened. And inasmuch as the wear of the battery depends simply on the current, the wear of the battery is likewise reduced by the activity of the machine.

It is easy enough to write down an expression for the strength of the current in terms of the power which the machine is exerting, *i.e.*, the work it is doing per second, by simply solving equation (2); and it is

$$C = \frac{E}{2\,R}\left\{1 + \sqrt{\left(1 - \frac{4\,R\,P}{E^2}\right)}\right\}$$

which shows that the greatest possible mechanical power obtainable by perfect appliances from the given circuit is $\frac{E^2}{4\,R}$; and that when this is obtained an equal amount is expended in generating waste heat. Moreover it shows that the consumption of material in the battery under these circumstances is exactly half what it is when the machine is held stationary and not allowed to work, and that no slower battery-wear than this half-rate is possible, so long as the machine is really worked by the battery and is not driven by some outside power; but that any faster wear is easy, up to the maximum, when the machine is stationary, of $\frac{E}{R}$.

The maximum rate of wear is $\frac{E}{R}$, corresponding to external power, O, and internal or waste power $\frac{E^2}{R}$;

The minimum rate of wear is $\frac{E}{2\,R}$, corresponding to external power $\frac{E^2}{4\,R}$ and internal or waste power $\frac{E^2}{4\,R}$.

But if the mechanical power obtained be small and insignificant compared with that put forth by the battery, as is always the case with small size models which can never be efficient and economical motors,

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then the rate of wear is so nearly equal to its maximum value $\frac{E}{R}$ as to be indistinguishable from it except by careful measurements.

Just one point before closing. No more work is called for from the battery whether a solenoid be sustaining a weight or keeping a piece of iron magnetised, or whether it is doing no such thing. Under all stationary circumstances the whole of the energy is frittered away as heat in the coil: the mere holding up of the weight or keeping a magnet excited involves no direct expenditure of energy. For a weight may be supported by a pillar, or a magnet may be struck into permanence by hardening it and fixing its molecules.

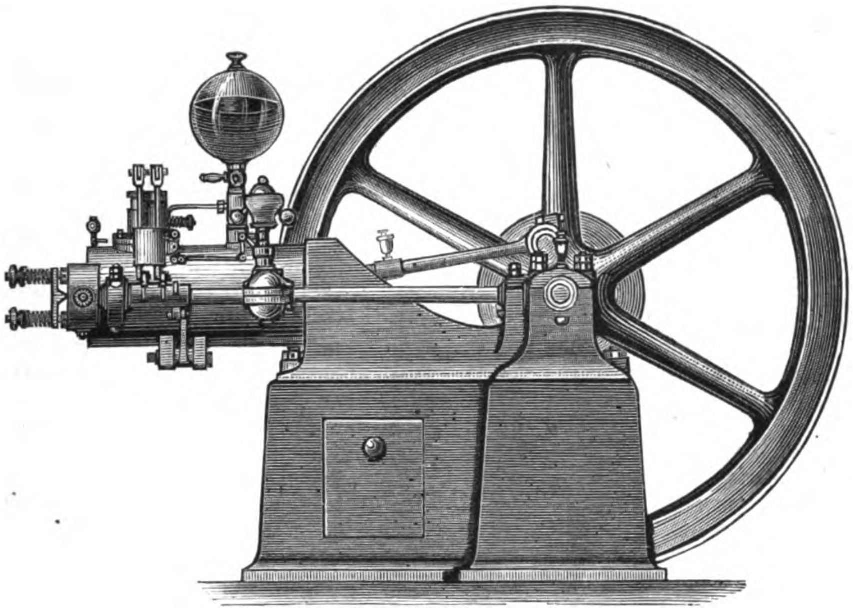
But a weight may also be supported by a man, or by a jet of water, and a magnet may be maintained by a constant current flowing round it: is there no expenditure of energy here? Do not the things get tired?

Yes, in truth they do, and there is expenditure of energy, *but not in holding the weight or maintaining the magnet*; it is all expended in bye-issues, it all reappears as heat. If we knew no simpler plan of keeping a weight supported than by keeping a man to hold it up, like Atlas, we should have to pay him his day's wage and keep him working, wastefully generating heat; but we do know a simpler plan—we use a prop. Similarly, as we know no simpler means of maintaining a powerful magnet than by keeping a current constantly flowing round it we have to keep such a current flowing, although we feel that it is really all running to waste, and that a simple prop would be a far better plan. This, however, is the present state of our ignorance; we know no prop for magnetism of any real strength. Here is a field for discovery; the field magnets of twentieth-century dynamos will probably be permanent ones, with the initial magnetic susceptibility of the softest iron, struck into the magnetic rigidity of the hardest steel.

SPIEL'S PETROLEUM ENGINE.

A VERY neat and successful form of petroleum engine, invented by Mr. Johannes Spiel, of Berlin, has lately been introduced into this country, and it is described in the current issue of *Engineering*. In its general appearance the engine, which we illustrate this week, very much resembles the well-known Otto motor, the points of difference relating mainly to the devices by which the motive fluid is measured and delivered to the cylinder, in admixture with the proper proportion of air. The cycle of operations is that with which the reports of the gas engine law cases have familiarised all the world; the piston on its outstroke draws in a charge of air and petroleum; it then returns compressing this mixture, which is exploded as the crank passes the back centre. The next stroke sees the combustion and expansion of the charge, while the fourth and last stroke of the cycle drives out the products of combustion. There is thus one acting stroke in every four, the motion being continued through the other three by the energy stored in the flywheel.

The source of power is petroleum spirit, otherwise known as benzoline, and also as naptha. This has a specific gravity of ·7 or ·71, and a very low flashing point, so that it will not pass the Abel test; consequently it cannot be stored and used without special precautions. If the proper conditions are observed the use of this spirit does not involve any extraordinary



risk, for it is employed in large quantities in the dry cleaning process, and also in the manufacture of India-rubber. When used with this engine it is stored in a closed receptacle connected by a pipe and hand pump to the reservoir. From this reservoir there runs a pipe to a pump, by which measured quantities are injected into the cylinder.

The firing light is the flame of a lamp which is kept constantly burning. At a suitable moment it ignites the burner in the valve, and by the quick return movement a flash is transported to the firing apparatus in the cylinder. The combustible mixture finds its way into the burner during the compression stroke. In front, and surrounding the burner, is a chamber which serves to convey a flame from the outer jet to the charge in the cylinder. The chamber forms an annular space round the burner, and a passage opens into this space, and maintains a communication for the supply of the combustible gas or vapour during the times when the main passage is closed. The gas passing through flows round the burner, and thus becomes heated and ignites more readily. When the chamber is filled with gas it is ignited by the outer flame, and continues to burn during the return stroke of the firing valve until the chamber comes opposite the main passage, when the charge in the combustion chamber of the cylinder is ignited. The maintenance of the firing flame is effected by the flow of gas through the passage.

The engine at present in this country will work up to $3\frac{1}{2}$ brake horse-power, with a consumption of about

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one quart of benzoline per horse-power per hour; the same rate of consumption is also obtained if the power be reduced to 2 horse-power. At the rate of 8d. per gallon, this represents an expenditure of 2d. per brake horse-power per hour. The motor works very satisfactorily, does not clog in the valves or cylinders, and bids fair to find a good field where gas is unattainable and the local rules concerning the storage and transport for petroleum spirit are not too stringent.

The engine is being introduced in this country by Messrs. Crozier & Co.

AN INTERESTING ELECTRIC LIGHT INSTALLATION.

THE installation of the electric light at the hunting seat of H.M. the Emperor of Austria in the Zoological Gardens at Lainz was entrusted to the firm of B. Egger and Co., of Vienna, that firm also manufacturing and supplying the electric machinery. The installation comprises about 250 incandescence lamps of 16 candles each for the illumination of the castle, kitchens, stables, and courtyard; and 120 lamps of 25 candles each for the lighting of the road.

The house which contains the machinery—the boiler being located in a separate room—has been erected near the main buildings in such a manner as to be concealed, and not to constitute an eye-sore. Two rooms for the attendants have also been provided.

With regard to the plant the greatest economy, compatible with the provision of a certain amount of reserve power, mechanical and electrical, was to be strictly observed. The following particulars of the installation will show that this was successfully accomplished.

The steam engine, as well as the boiler, was supplied to the contractors by the Simmering Engine and Waggon Construction Company (late H. D. Schmidt).

The boiler is cylindrical, with two internal flues; it will sustain a pressure of 6½ atmospheres. The heating surface is 63 square metres, and the grate surface is 2 square metres. The furnace doors are connected with the damper in such a manner that their partial opening causes a corresponding closing of the damper. The boiler is set in brickwork, and its exposed parts are carefully covered over with cork, so as to prevent the dispersion of heat.

In this manner 19 kilogrammes of the evaporated water per square metre are rendered available with a minimum consumption of fuel, so that the boiler is capable of supplying steam equal to 80 indicated H.P. per hourly evaporation of 1,200 litres of water (assuming that non-condensing engines consume 15 kilogrammes of steam per indicated H.P.).

The engine is required to work normally up to 35 H.P. It is a twin engine with cylinders coupled under 90°. Diameter of cylinders 325 millimetres, stroke 650 millimetres, number of revolutions 65 per minute.

If one of the cylinders should be damaged, the other cylinder will be able to supply the required 35 H.P.

The admission of the steam, which is effected by a Waniek precision slide valve, is regulated by a Porter governor. The main steam pipe is 120 millimetres in diameter, the cylinder steam pipes 80 millimetres each, the main exhaust 150 millimetres, and the cylinders exhaust 110 millimetres each.

The cylinders are surrounded with cork and wood. A super-heater of about 16 square metres heating surface is provided.

An eccentric on the crank axle works a plunger feed pump, sunk in the floor, of 100 millimetres diameter and 120 millimetres stroke. All the pipes leading to and from the engine are placed beneath the floor.

The driving pulley of the engine rotates by rope gearing of the best hemp a driving shaft by which four dynamo machines are set in motion by means of belt gearing.

Two of the four dynamos light the buildings, and the other two light the road. The machines which illuminate the castle feed about 250 lamps of 16 candles each. Each machine is, however, constructed to run a maximum of 170 lamps. They are continuous current shunt-wound machines of 110 volts between the terminals, and are coupled together. The internal resistance of each machine is 0·1 ohm. The current is regulated by means of resistances switched into the the shunt. The machines are driven at 750 revolutions per minute, feeding 9·6 lamps per H.P.

The incandescent lamps in the castle buildings are joined parallel. The wires are well protected and placed underground; they are made up into lead cables enclosed in tubes of prepared wood, or into cables embedded in the best asphalte and contained in solid wooden boxes. Specially insulated wires are used for the connections of the lustres.

The road which is lighted by electricity leads from the engine house to a place called Speising, whilst a branch connects it with the hunting seat. It is about 3,600 metres long.

The lamps are joined in series; they are provided with automatic shunts in order to provide against an interruption of the circuit by the casual breaking of a lamp. The lamps used are the Bernstein (Boston) incandescence lamps of about 6 ohms resistance each, giving a light of 25 candles when fed by a current of 3·5 ampères, with an E.M.F. between the terminals of 18 volts. The lamps are enclosed in globes of frosted glass, they are fixed on posts on both sides of the road at a distance from one another of 30 metres.

The lamps on each side of the road form separate circuits which are each fed by a dynamo, so that, if one of the dynamos should be thrown out of use by some accident, the other side of the road would still be sufficiently lighted. The line along the road consists of uncovered copper wire, 3 millimetres thick, fastened to insulators of porcelain fixed on the lamp posts. The leads are of the best insulated material and pass through porcelain tubes into the hollow post and thence to the lamp. The whole resistance of each circuit, inclusive of the automatic contacts, is 20 ohms. It may be mentioned here that a telephone line from Schönbrunn to the hunting seat is carried along the lamp posts, and that the correspondence does not suffer the least interruption from the lighting current.

The two dynamo machines which light the road have an internal resistance of about 60 ohms; their speed is 750 revolutions per minute. The measuring instruments used are the voltmeter and the ampèremeter, &c. (Drexler's system); for the buildings' circuit 1 voltmeter is used, and for the road circuits 1 ampèremeter for each circuit. Those apparatus are provided with controlling bells and automatic contacts, so that the attendant is informed of the admissible minimum or maximum current strength. The cost of the entire installation amounted to 48,000 Austrian florins (£4,800).

As the firm of B. Egger & Co. manufacture the Boston incandescence lamps at their works, we may say that the whole electrical plant, inclusive of the measuring instruments, &c., was constructed by them.
—*Zeitschrift für Elektrotechnik.*

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

VIII.

LET us now consider the case of a tramway which is to be worked electrically; the energy we assume is to be transmitted through a conductor; it may be an overhead conductor on the Siemens plan, or underground as used by Mr. Holroyd Smith, or a side conductor as adopted by Mr. Trail in Ireland. We take for an example a line, A, B (fig. 8), with a double track; the distance from the starting point, A, to the terminus, B,

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is 3 miles; each car has thus to travel 6 miles to perform a double journey. There are no sharp curves, but the road is not level by any means. Starting from A we have a downward slope of 1 in 75 for a distance of ·3 of a mile, then a level piece of ·2 of a mile in length, then follows an up gradient of 1 in 30 for the short bit of ·14 of a mile; next comes a level road of 1 mile in length, then a down gradient of 1 in 50 for ·8 of a mile, and finally a rise of 1 in 100 for a distance of ·56 of a mile, making a total of 3 miles for the outward journey and the same distance for the return journey. The two sets of rails being laid parallel to each other, we have to reverse the order of things in going back, so that where we had up gradients in the outward journey there are now down slopes.

We take, again, a car capable of holding 40 passengers weighing together 2·5 tons; the vehicle itself weighs 2 tons and the whole propelling apparatus half a ton. This car, when running at the rate of 6 miles per hour absorbs, on the level road. 2,764 watts or 3·76 electrical horse-power.

For simplicity's sake we take the E.M.F. at 200 volts, and we assume it to be constant throughout the line. The generating station (engine and dynamo) we place as near to A, the starting point, as convenient, with the

In the Return Journey, B *to* A.

2956·8	feet, down 1 in 100	736	3·68	1·0
4224	„ up 1 in 50	6889	34·44	9·36
5280	„ level line	2764	13·82	3·76
739·2	„ down 1 in 30	0	0	0
1056	„ level line	2764	13·82	3·76
1584	„ up 1 in 75	5520	27·6	7·5

CURRENT AND TIME.

Outward.			Return.		
3 min.	Amp. min.	0	5·6 min.	Amp. min.	20·6
2 „	„ „	27·64	8 „	„ „	275·52
1·4 „	„ „	33·75	10 „	„ „	138·2
10 „	„ „	138·2	1·4 „	„ „	0
8 „	„ „	0	2 „	„ „	27·64
5·6 „	„ „	136·81	3 „	„ „	82·8
Average $\frac{336·39}{30}$ = 11·21 amps.			Average = $\frac{544·76}{30}$ = 18·158 amp.		

Thus, in the double journey, if made in 60 minutes, the average current expended by the motor should be 14·68 ampères.

The heat waste caused through the conductor resistance varies with the square of the current strength, and in order to ascertain its average value we have to take the time into consideration.

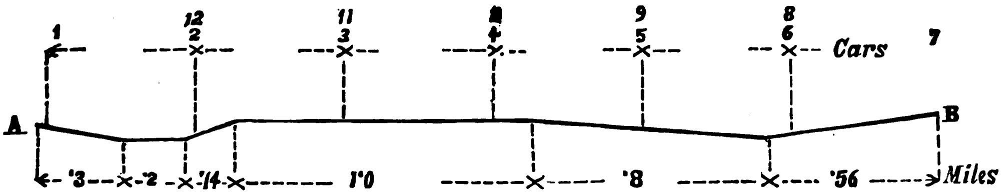

FIG. 8.

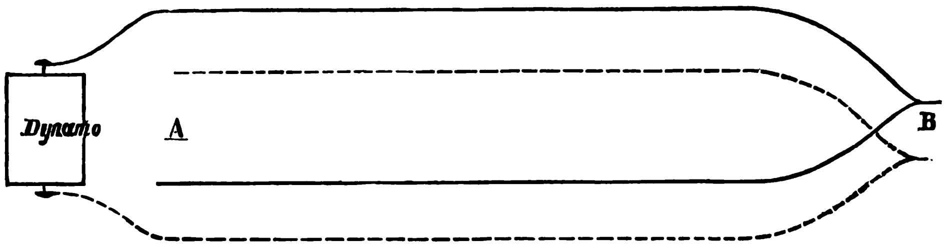

FIG. 9.

copper conductors, as indicated in the diagram (fig. 9), where the thick black line represents the copper rod and the dotted lines are the return leads, formed of the rails themselves.

If this car is to run at a uniform speed of 528 feet per minute, then we have to provide it with a motor capable of utilising 12·8 electrical H.P. when on the stiffest incline. When travelling down hill the vehicle will move by gravitation alone, and the average power absorbed during the journey will be 3·99 H.P. The resistance to traction is taken at 30 lbs. per ton, therefore this car will only run down the incline of 1 in 75 at its normal speed without expending electric energy. Down the steeper grades we have to apply the brake, and down the lesser gradient a small amount of current will be required.

If it were possible to construct a motor which could adjust itself exactly to the load, working at a constant speed and with a constant efficiency, then the power absorbed would come out as follows :—

POWER AND CURRENT RATE.

In the Outward Journey, A *to* B.

1584	feet, down 1 in 75	0 watts	0 amps.	0 H.P.
1056	„ level line	2764	13·82	3·76
739·2	„ up 1 in 30	9421	47·1	12·8
5280	„ level line	2764	13·82	3·76
4224	„ down 1 in 50	0	0	0
2956·8	„ up 1 in 100	4887	24·43	6·64

We get thus in the outward journey, during

3 minutes	$0^2 \times 3$	× ·4
2 „	$13·82^2 \times 2$	
1·4 „	$47·1^2 \times 1.4$	
10 „	$13·82^2 \times 10$	
8 „	$0^2 \times 8$	
5·6 „	$24·49^2 \times 5·6$	

and during the return journey

5·6 minutes	$3·68^2 \times 5·6$	× ·4
8 „	$34·44^2 \times 8$	
10 „	$13·82^2 \times 10$	
1·4 „	$0·0^2 \times 1·4$	
2 „	$13·82^2 \times 2$	
3 „	$27·6^2 \times 3$	

giving an average of 153·8 watts wasted in heating the conductors with one car on the line.

But the tramway service is to be so arranged that cars should follow each other at intervals of five minutes; we require, therefore, 12 such cars to do this. When all the cars are running together, at equal distances apart, we are at one moment using the following current rates :—

Outward.		Return.	
1st car down ...	0 amps.	7th car down ...	3·68 amps.
2nd „ up	47·1 „	8th „ „ ...	3·68 „
3rd „ level ...	13·82 „	9th „ up ...	34·44 „
4th „ „ ...	13·82 „	10th „ level ...	13·82 „
5th „ down ...	0 „	11th „ „ ...	13·82 „
6th „ up	34·44 „	12th „ down ...	0 „

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a total of 178·62 ampères at the instant of the above arrangement, and this represents 48·54 H.P. at the terminals of the motors; adding to this the energy wasted in the leads at this particular instant, viz., $\frac{178{\cdot}62^2 \times {\cdot}4}{736} = 17{\cdot}3$ H.P., we obtain a total of 65·84 H.P. at the terminals of the generator. No account is taken of any leakage on the line. The terminals of the motors are assumed to be arranged in parallel with the conductors.

HOWARD AND HAIG'S PRESS BUTTONS.

THIS is a contrivance designed for the purpose of reducing the cost of electric bells in small houses.

Externally it resembles an ordinary press button, but behind the ornamental boss is a cylindrical chamber, about 2¼ in. in diameter by 1¼ in. deep, at the back of which are the binding screws to which the wires are to be connected. This chamber contains the mechanism, which may be thus described:—

The press rod or button, when pushed in by the finger, depresses the head of a kind of bellows (the air within which escapes freely by a valve provided for that purpose), and at the same time carries a contact spring over one or more contact studs, separated from one another by a non-conductor. A circuit is, therefore, formed only as the spring passes over each stud; but under the pressure of the finger this is done with such slight intervals as to produce a continuous ringing of the bell.

When the finger is removed, the bellows head or piston is made to recover its normal position by means of a spiral spring, but the valve now closes, and the air being admitted very gradually, the recovery is necessarily slow.

Sensible intervals of time are, therefore, occupied in the transition of the contact spring from one stud to another; and, again, some time is occupied in its passage over the studs themselves; hence a succession of rings is obtained automatically, two, or three, or four, according to the number of intervals in the press employed. Thus, three or four separate rooms in a house are distinguished by their numerical ring; three or four more may be similarly distinguished by a bell of a higher pitch; and so on, to any moderate number.

This system renders a separate indicator unnecessary, thus saving an expense of some 30 per cent., or more, in the fitting of these appliances; it also saves the trouble of *going to look at an indicator*, which is sometimes very inconvenient. The principle, too, is capable of being applied to other uses besides domestic bells.

The sole manufacturers are Messrs. Howard and Haig, and their invention is provisionally protected.

ON TELEPHONE SYSTEMS.*

By Prof. AMOS E. DOLBEAR.

THE subject of the telephone is not so old as some other subjects that might be named, but within the past 10 years it has engrossed so much attention in the way of experiment in all civilised countries, and has been the text for so many discourses that it is hard to find anything that shall be new to such a body of listeners as I have before me. I cannot hope to add to your knowledge, and my aim will therefore be to summarise the principles that underlie telephony, and the methods that have been adopted in developing it.

I would first remark that when any physical end is to be reached, there are certain physical conditions which must be recognised, viz., the laws of matter and of energy. There can be nothing accomplished in the physical world without it. Matter always is subject to its own laws, and the relations of matter to energy are such that no transformation of the latter ever takes place except through the agency of matter. Indeed, it would be true to say that the body of physical science is made up of statements of the conditions under which energy is transformed.

We may call these the laws of nature; they are the conditions under which we live and to which we must conform, for a physical law can never be traversed. A balloon rises in the air not in spite of gravity, but on account of gravity. The pressure of steam is due to molecular impact, and if the molecular velocity be great enough, the boiler bursts. If the railroad train is to be run fast there must be no short curves in the road, for Newton's first law threatens disaster to such a combination.

Physical relations or laws then are fundamental, and every working machine works in accordance with them, whether the maker understood those laws or had them in mind or not. In the days when the commonly held theory of heat was what is now known as the Caloric theory, the steam engine worked just as it does now, and the development of the kinetic theory of gases, and a clearer understanding of heat phenomena has not affected the motion of a single molecule. Clearly, then, individual *intention* has nothing to do with physical laws involved in any piece of mechanism.

All mechanical devices embodying energy are either transformers, transferrers or governors. A furnace is a *transformer* of the chemism of coal and oxygen into heat. The boiler is a transferrer of heat to the water endowing it with greater molecular energy. The engine is a transformer of the heat energy into visible mechanical rectillinean and rotary motions, while the main shaft is again a transferrer of rotary energy to the distant room where, through the agency of pulleys and belts the transformations are chiefly such as change the character or direction of motion, converting rotary into reciprocating motion, or *vice versa*, &c. In like manner a galvanic battery is a transformer of the energy of zinc and acids with electrical energy. The leading wires are transferrers, conducting the electrical energy where it is needed, while the relay or sounder is again a transformer of the electrical energy into mechanical motions of an armature which may record its own movements, or the latter may be interpreted at once by an experienced listener. If a Morse key be put in such a circuit, it is as a controller of the transformations, and of course of the transference as well. It neither adds to nor subtracts from the energy, it simply controls it. So long as the Morse key is manipulated by hand, the electric energy available is subject to the will of the operator, only, however, in its *rate of delivery*, not as to its generation, its velocity of transmission or its transformations in the sounder. Those are the physical relations which are beyond the reach of any intention, and could not be changed by any will or wish the manipulator might have.

It is, however, possible to make an automatic governor or key which shall so control the electricity as to produce a set of signals similar to those made by hand, but this automatic device is built upon physical principles, has its own laws of working, and, *while it is working*, is not subject to any one's dictation or will or wish. If it does its work properly it is because it is made in accordance with the laws of matter and of energy, which are concerned in its working, whether the maker knew all those laws or not. It is as true for such a piece of mechanism as for a boiler injector or the governor of a steam engine. These principles or laws are simply *adopted*, not adapted; the mechanism is always *adapted* to the principles or physical laws which are to be operative, and it is right that the distinction between physical laws and the apparatus through which transformations of energy or the control of energy, are possible, should not be lost sight of, for I have known where the statement of the recognition of a physical law in the sense in which I have

* A Lecture delivered before the Franklin Institute, Friday, December 11th, 1885.

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described it, has been made as a claim upon the physical law itself. The law has allowed it, and the court has awarded it.

What, then, are the physical conditions which underlie the electric transmission of speech? Speech—articulate speech—consists of sound vibrations in the air, generally of a highly complex character. The sounds themselves are partly arbitrary and partly automatic; that is, what I call a tree a Frenchman would call *l'arbre*, and a Chinaman something else. So much is purely arbitrary, but there is a difference—a physical difference between my word tree and your word tree, which no amount of painstaking on my part could make identical, the character of my voice is not subject to volition; it is as automatic as the sound of a violin or of a cornet, and that for the reason that the instrument that produces it is a physical instrument, having its own laws of vibration and resonance. The pitch may be varied, but not the quality, and so it is for a cornet or a violin. Articulate sounds are the arbitrary ones, and have no particular character like musical instruments, no particular series of harmonics belongs to speech, but articulate sound vibrations in air involve *energy*, and can only be maintained by the expenditure of energy, and any question of the transference of such vibrations from one point to another is simply a question of energy. If the distance be not too great, there may be enough energy in the vibrations in air to affect the auditory nerve of a listener, and no transformation will be needed. If the sound waves are prevented by a tube from spreading spherically in space, the energy will not be so wasted, and the sounds be heard at a greater distance, but there is a limit there, and if speech is to be rendered at a greater distance, apparatus for transformation and transference must be employed. If electricity is to be used, then the relations, if any, between sound vibrations and electrical phenomena must be employed. We might be supposed to know that electricity quickly distributes itself in a metallic circuit, and also that a Morse key enables one to send electric pulses at will through an electric circuit. But a key that will respond to sound vibrations *must necessarily be automatic*, for no hand can move with the rapidity and variety of sound vibrations. When sound vibrations fall upon any surface they impart a portion of their energy to it, and cause it to vibrate in a similar way. One may whisper close to a closed door, and be heard by one whose ear is against the other side of the door. The smaller and thinner the surface against which such sound waves spend themselves, the greater will be the amplitude of the movements. Let such a surface, capable of responding to any sound vibration, be provided with freely moving electric terminals, so that every vibration shall send into the wire a corresponding electric impulse or wave, and we have a device that will do for speech in an automatic way what the Morse key will do when manipulated by hand, namely, vary the strength of an electric current in the circuit in accordance with certain arbitrarily chosen symbols. Such a device is now generally called a transmitter, but in reality it is an automatic governor, as its function is to control an electric current operated by the variable energy of sound waves. So far as the apparatus described does what has been said, we have an electric circuit in which the electric energy is a variable quantity depending upon the vibratory movements of the tympanum, and this may be from the maximum quantity which the provided conditions permit, to nothing if the current be entirely broken.

With the Morse key, this range is reached for each signal; with the other, the range cannot be so great without danger of omitting some of the vibrations that constitute the sound. The sound vibrations in the air are a series of continuous waves so long as the sound is being produced. If the velocity of sound in air be, say, 1,125 feet per second, and if a sound of any kind be produced for, say, one second, then the first wave will be 1,125 feet from the last wave, and between them will be an unbroken series of similar ones. If such a series had acted upon the terminals of the electric circuit, the same unbroken series of electric waves would have been produced.

WHAT IS A SYSTEM?

A system is a series of steps or processes employed to attain some end or accomplish some purpose. Some things may be done with a single movement, yet there are few things that may not be done in more than one way. A tree may be cut down with an axe, or sawn down either by hand, or by a circular saw run by steam, or it may be burned off by a platinum wire made red hot by electricity, or it may be gnawed off by beavers.

If time is to be kept, it must be by some *uniform movement*, which may be secured by a pendulum or balance wheel, each in train with a set of gears and a weight or a spring. The end attained is the same, but the steps are different, and these may properly be referred to different systems or methods. Uniformity of action is the physical, necessary condition for time-keeping, but uniformity of action is not a method of time-keeping.

If the early maker of a pendulum clock had said: "I have discovered that in order that time should be kept, it is necessary to have a uniform, mechanical movement, and I have invented a pendulum to effect this; I, therefore, claim the method of and the apparatus for time-keeping;" if some patent office had granted such a patent, and if the courts had upheld the claim, the case would be paralleled by the celebrated fifth claim of the famous telephone patent of 1876. It might be true that no one had stated the condition so tersely before, yet the Clepsydra embodied the proposition and astronomers had predicted eclipses on the basis of uniform motion for time-keeping for thousands of years before.

Morse proposed a telegraphic system consisting of a battery, a key, a transferring wire, and an electro-magnet, with a movable armature, which should record its movements. Not one of the steps was original with him. He invented neither battery, nor key, nor conducting wire, nor electro-magnet, but he combined these in such a way as to produce valuable results, at distances which had not been reached before. Bain proposed a telegraph system, in which a battery, a key, a wire, and an electro-chemical instrument were employed. Neither of these steps did he invent. The differences were, briefly, that where Morse employed magnetism and its mechanical relations, Bain employed chemism and its optical relations. One embossed paper, the other made a blue mark upon it. But the differences were deeper than this, for the battery-power needed to do the work was much less in Bain's than in Morse's, and, moreover, there is a limit to the speed with which an armature of a magnet can move, and, therefore, a limit to its telegraphic speed, but there is no such limit to the speed of such chemical reactions. Indeed, the only reason I ever heard for the abandonment of Bain's system was its unnecessary delicacy. In each of these systems, the electricity which was to do work was fitted at the transmitting end for the work it was to do at the receiving end, and the movements, of whatever sort, at the receiving end, had corresponding motions of the key. Then there was the dial system of telegraphy, wherein a finger moving round a dial caused a similar movement of a finger about a receiving dial. In each and all systems, it was recognised as a physical necessity that if electricity was to do a certain work, it must be fitted for it at the transmitting station. If dots and dashes are wanted, they must be made at the transmitting station. The wire is employed simply as a transferrer, not as a transformer, and if it has such a transforming property, its efficiency as a conductor is so much impaired, the amount of energy it can transmit in a given time is less, and the characteristics of the energy are more or less effaced.

It is not, then, singular to the telephone that the characteristics of the energy needed at the receiving end should be given to the electricity at the transmitting end, but on the contrary, it is the physical condi-

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tion that underlies all electrical apparatus whatever and depends solely upon the laws of the transformation and conservation of energy, and must be conformed to, as any other laws must. To give a new crook to a magnet, or vary the relations of mechanical details in a transmitter, and call them a new system, is, to me, as ridiculous as it would be to paint the parts some different colour and then christen it a new thing. That is not saying but that such changes may be improvements, but so long as the series of changes is precisely the same, from beginning to end, in both transmitter and receiver, I do not recognise the appropriateness of calling anything a new system. A different set of changes, involving different transformations of energy, different laws requiring different apparatus, I do call a different system, and these must belong to both transmitter and receiver.

In conformity to this, what are the possible ways by which sounds of any sort may be electrically transmitted and reproduced at another place?

(1.) As to the so-called transmitter, or the device for fitting the electric energy for the work it has to do. There are two ways in which electric energy in a given circuit may be controlled. (I.) By varying the resistance, and (II.) by varying the electromotive force in it. If there be any third way, I do not know of it. If, then, the energy of sound waves can be so utilised as to vary the resistance in an electric circuit in conformity with the varying phases of the sound waves, we shall have one method, and as there is to be no transformation, it is evident that the action will be wholly mechanical, for the sound vibrations themselves are but mechanical movements in an elastic medium, and if there be no transformations, the last term of the series will be mechanical in the same sense.

If sound energy can be made to vary the electromotive force in a circuit, without changing the resistance in the circuit, then we shall have another and a different kind of transmitter. The discovery of magneto-electricity makes it possible, and some of the very first magneto-electric experiments pointed out the way, namely, the generation of electric currents by means of the motion of the armature of a magnet.

(2.) As to receivers. The range of possible receivers is not restricted as is that of transmitters and a great number of ways of utilising the electrical energy that has been properly adapted by a transmitter have been devised. It will be well here to recall the various effects which electricity is competent to produce.

(I.) Electricity is competent to affect a magnet, which tends to set itself at right angles to the wire through which the current flows. Ordinary galvanometers are constructed to utilise this action of electricity.

(II.) Electricity is competent to produce a magnet, and upon this property the common electric telegraph and hundreds of other applications have been founded.

(III.) Electricity is competent to decompose compound-chemical substances, as, for instance, water; and for the utilisation of this property of electricity, a common and simple one is the production of a blue mark by means of the decomposition of the ferrocyanide of potassium as in Bain's electric telegraph.

(IV.) Electricity is competent to deposit one metal upon another metal, and from this property has grown up the great industry of electro-plating.

(V.) Electricity is competent to produce heat, the highest temperature which man is able to produce at present is that in an electric arc, and is used for the fusion of refractory substances, such as platinum, gold, and steel.

(VI.) Electricity is competent to produce light, and the two systems of electric lighting, namely, that by the arc and that by incandescence, are developments of the possibilities in that direction.

(VII.) Electricity is competent to reduce the friction between bodies, and this property has been utilised by Edison in one of his telegraphic systems.

(VIII.) Electricity is competent to produce either heat or cold at a junction of metals, according as the current flows this way or that, which is known as Peltier's phenomenon.

(IX.) Electricity is competent to produce various physiological effects, and is extensively used as a therapeutic agent.

(X.) Electricity is competent to give a torsional strain to a conductor through which it flows, either right handed or left handed, according as the current is towards or away from the observer. This has been used to measure the strength of the current flowing through the wire as a kind of galvanometer.

(XI.) Electricity is competent to produce very various gaseous phenomena, and a visible motion of paddle-wheels, by the impact of gaseous molecules, as is exhibited in various forms of Crooke's tubes.

(XII.) Electricity is competent to twist a ray of light in air or other transparent medium, but this is at present used, so far as I know, only in the investigation of physical phenomena among molecules.

(XIII.) Electricity is competent to produce in the non-material substance, called ether, a certain condition, which is generally known as the electric field, a field within which various interesting phenomena are manifest, and which are at present the subject of investigation by physicists.

(XIV.) Electricity is competent to produce a noise or sound by disruptive discharge, as in the phenomena of thunder storms and on a small scale by electric machines and Leyden jars.

(XV.) Electricity is competent to produce attraction, but this phenomenon, which has been known perhaps longer than any other of an experimental electrical kind, has not been utilised to any considerable extent.

It is not improbable that there are other things which electricity will do, which I have not enumerated, or that will hereafter be discovered. It is possible to make nearly every one of these effects available in a telephonic receiver.

It is not my intention to undertake any settlement of historical matters in connection with the telephone, nor to enter upon any questions of priority, and the names which I shall employ to designate the different systems I describe, I only adopt for the sake of distinctions which exist, and these can be more easily kept in mind if so individualised, than in any other way.

Farrar, of Keene, N.H., discovered in 1851, by experiments with electro-magnets and vibrating reeds that completed and broke an electric circuit, that the

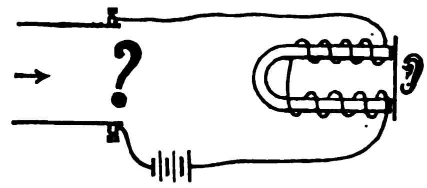

FIG. 1.

magnet was capable of responding simultaneously to several distinct series of such reed vibrations, and that suggested to him that if he could contrive to vary the electricity in the circuit by voice vibrations, as he did with the reed vibrations, that he could electrically transmit speech. He was not able to devise an appropriate transmitter, and was discouraged from the attempt by the expressed opinion of the impossibility of doing it by Prof. Silliman. He had, however, the receiver, and had proved its ability to act in the way proposed. I cannot allude to Farrar's system as complete, for the work was but half done, and I, therefore, put in the place of the transmitter the interrogation point, to indicate what was lacking.

REIS'S SYSTEM.

Nearly ten years after that, Reis, of Germany, invented the mechanism that Farrar lacked, namely, an apparatus that was capable of responding to the minutest shades of acoustic vibrations, and having an automatic attachment making part of an electric circuit, the motions of this attachment, or the electrodes, as it may be called, being governed altogether by the sound-waves in the air.

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Reis made a number of transmitters, varying the mechanical details in each, but they all had in common a membrane stretched taut over an aperture, and against which sound-waves of any kind were to impinge. This membrane had fastened to its middle a thin strip or disc of platinum foil, which was connected by a wire to a binding post. Connected to

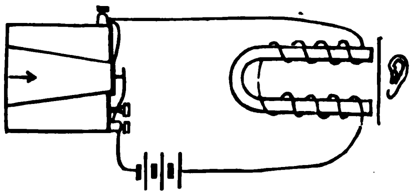

FIG. 2.

another binding post was a metal strip reaching to the middle of the membrane, where a piece of platinum wire, fixed at right angles, was so adjusted by a screw as to touch gently upon the platinum disc and so complete the electric circuit with a battery, and an electro-magnet for a receiver. The energy of the sound-waves was employed to control the electric energy in the circuit, and it was expected that any change in the one would make a corresponding change in the other. That Reis expected this, is perceived in his lecture, where he gives the curves for compound sound vibrations in air, a continuous and not a broken one, which, if it was to be transmitted and reproduced, must not have lost any of its characteristics. It is certain that he intended to have reproduced in his receiver all the characteristics of the sounds made at the transmitter. He explains the action of his transmitter as making and breaking the circuit for every vibration of the membrane, and a deal of wearisome talk has been made of late years about Reis's *intention*, one party declaring the intention to be in the function of the apparatus to transmit and reproduce sounds of all kinds with their characteristics, and they point to Reis's statement that he thus did transmit and reproduce the sounds of the piano, accordeon, clarionet, horn, organ pipes, and speech. The other party declares that Reis's intention was to make and break the circuit for every vibration, and, therefore, he could not possibly have intentionally transmitted speech, for a continuous circuit and an undulatory current are essential to do that. If, therefore, Reis did do what he says he did, it was accidentally done, and the apparatus was not working as it was intended to work. It ought to be remarked, that if the tones of the above-named instruments were reproduced, there must have been the same continuousness that is now insisted on as being essential for the transmission of speech, for the sound of a piano string is made up of a number of separate tones in harmonic series, and continuity is as much a characteristic of such sounds as of any other. But Reis distinctly says that he was able to transmit human speech, adding, "though not with distinctness sufficient for everyone," which implies, if anything, that it was distinct enough for some. Reis explains the lack of distinctness to which he alluded as being due to the fact that the higher overtones were too weak in the receiver for all to hear, not that some of them were not present at all. But that objection of a lack of distinctness was brought against the telephone of the present day. Over and over again, I have heard persons say, when first listening to a telephone that was speaking well, that they couldn't hear what was said, and I dare say everyone has had a similar experience who has worked with telephones to any extent. The fact is, that nearly everyone requires some experience with a telephone before he can make out all that is said, and Reis's audience was not made up of experienced persons. There is, however, no reason at all to doubt that Reis did transmit speech with his apparatus, for, as I have said before, the working of the transmitter is *automatic*, and depends upon the sound-waves that fall upon it, and not upon anyone's intention of how it shall do its work. Take any Reis transmitter and couple it in a circuit with a battery without anything for a receiver. Now, speak to the transmitter. Will the sound-waves vary the current strength in a proportional way? In other words, will the current be the kind known as undulatory, and one capable of reproducing the words spoken? There is only one answer to this question; there are no ifs nor buts about it. Whether they be heard or not, is another question depending upon the kind of device used for transforming the electric energy, and its degree of sensitivity, also, the acuteness of hearing of the one who listens. If an electro-magnet ill adapted to the conditions be used for a receiver, the speech might not be heard, but it would not be because the character of the work of the transmitter was at fault, but because the receiver was not delicate enough. To say otherwise, would be like denying the existence of a current of electricity in a circuit, because the needle of a galvanometer made for strong currents gave no indication of one. If it is of any importance to know whether there be a current or not, include in the circuit the most delicate galvanometer to be had. The test for the character of the working of the Reis transmitter is similar; put the most delicate receiver at hand in the circuit and listen. When such a test as that is applied, it is always found that the current from a Reis transmitter is identical with the one in common use to-day for telephonic purposes. Where this is done, however, the deniers of Reis's claim assert that the transmitter works on account of knowledge acquired since 1876, but they know better, and argue thus for commercial reasons only. Indeed, I think it proper to say here that I have conferred with a great number of electricians in various parts of the country about this matter, and there is the greatest unanimity concerning it, that Reis did invent a speaking telephone; that he used it for that purpose, and that it works in the same way as does the modern commercial telephone. A number have given me testimonials to that effect, and several who do not wish to be mixed in the controversy, express privately to me the same views precisely. The only ones that oppose it are those who have a pecuniary interest in denying it.

Reis's system of telephonic transmission consists in the employment of sound vibrations to operate upon electrodes, so as to vary the resistance at the electrodes, and thus control the current in conformity to the sound vibrations. His transmitter is more properly an automatic governor of the current, which is provided by a battery in the same circuit. His receiver consists of an electro-magnet, mounted upon a resonant case. Of these there are two varieties: One, an electro-magnet without an armature, in which the varying current changes the magnetic strength, causing a corresponding molecular rearrangement, which produces the sound in air reinforced by the case; the other, an electro-magnet with an armature, provided with a spring to oppose the magnetic attraction on the one side, and a stop screw to prevent contact with the poles on the other side. The main source of the sounds in this is due to magnetic induction upon the armature, just as in the telephone of to-day. This, too, is mounted upon a resonant case. The instrument very closely resembles a common relay, the horizontal magnet, the hanging of the armature and the recoil spring are all there, and, as might be supposed, a relay makes a tolerable receiver.

Yeates, of Dublin, placed a drop of water between the platinum electrodes in Reis's transmitter, and thus prevented the absolute break in the current to which Reis was liable; he also mounted the electro-magnet of the receiver in a better way, and so got better results. Dr. Messel, of London, who was one of Reis's pupils, told me that Reis himself placed water and sulphuric acid and sulphate of copper solution, and various other solutions, in the same place and for the same purpose. This experiment of Yeates, which is well enough authenticated for history and credence, teaches one lesson that has been overlooked so far in this telephonic controversy. It has been said over and over again, that if Reis had actually achieved the elec-

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tric transmission of speech, that everybody would have heard of it, that it could not have been buried and so little known of it, because the achievement was one of the highest importance, and therefore, if so little was known of Reis's speech transmissiom, it was because

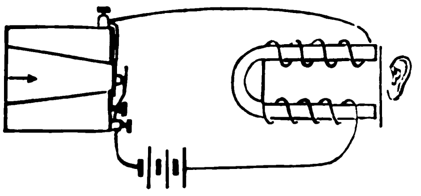

FIG. 3.

he didn't do it. But it is not denied that Yeates did it in 1866, and that it was known at the time at the University there, but it did not appear to be of enough importance to even chronicle. Silence, therefore, does not tell against Reis, but against the contemporaries of Reis and Yeates.

The grandest invention is of but little worth, except it be allied with business tact and energy. A steam engine is good for nothing without coal and stoking.

Elisha Gray, of Chicago, designed a speaking telephone and entered a caveat for it in the Patent Office early in 1876. The only difference between his plan and that which I have described, consists in the structure of the transmitter, which consisted of a metallic vessel containing a liquid conductor, the top covered with a diaphragm, carrying at its middle a wire con-

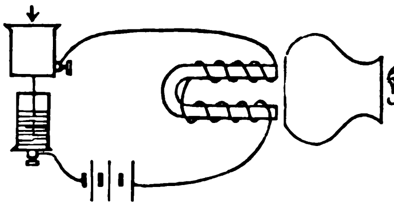

FIG. 4

ductor, reaching down into the liquid. This wire was made part of an electric current with the solution and vessel, a battery and an electro-magnet with armature for receiver. Any sound made at the diaphragm moved the wire in the solution in a corresponding way, and so varied the strength of the current by varying the resistance in the liquid. The receiver had the electro-magnet armature mounted upon a tube, which was advantageous for listening, as the sounds were thereby prevented from scattering to the degree they did with Reis's mounting. It did not differ in principle from Reis for the series of reactions from the sound to be transmitted, to the one that reached the ear, were practically the same, namely, the air vibrations acting upon an electrode varied the resistance of an electric circuit maintained by a battery, and the varying current varied the magnet's inductive strength upon the armature, causing it to move in accordance with such current changes.

McDonough, also of Chicago, about the same time had modified a Reis transmitter by making multiple platinum contacts, and lessening the liability to the disruption. His receiver was similar in structure to Gray's. This, considered as a system, is identical with Reis's.

Drawbaugh, of Pennsylvania, and Meucci, an Italian, both lay claim to the inventions of this system.

(*To be continued.*)

Bleaching by Electricity.—The *Dyer and Calico Printer* is publishing articles from the pen of Mr. W. Watson on the subject of bleaching by electricity, respecting which a short article appeared in our last issue.

ELECTRIC LIGHTING OF H.M.S. "DEVASTATION."

THE official trial of the electric light installation on board H.M.S. *Devastation*, stationed at Queensferry, and which has been fitted throughout by Messrs. Goolden and Trotter, of Westminster and Halifax, took place on Saturday last, the 6th inst. The ship is fitted with two powerful search lights of 27,000 candle-power each, the projectors and hand-feed lamps for the same being by Messrs. Latimer Clark and Muirhead; there are also two yard-arm reflectors, both containing 8 lamps of 40 C.P. each.

Internally, the lights consist of 265 lamps of 16 C.P., of the Edison and Swan type. The arrangement of the lighting was very complete, the lamps being placed to illuminate every part of the ship, even to the screw alleys and magazine light boxes, while every coal bunker in the stoke-hole was supplied with a wandering lead.

Mr. Richards, from the Admiralty, and Mr. Lane, the Portsmouth Dockyard electrician, arrived on Thursday, and a preliminary trial took place in the afternoon, which was continued on Friday, in order to thoroughly test all three dynamos and engines. The official inspection commenced at 7 p.m. on Saturday, and terminated at 10 p.m., everything working perfectly; all switches were tested, and portable lamps tried. At the conclusion of the trial Lieutenant Laborde, who represented the captain at the trial, congratulated Mr. Scott, the engineer to the contractors, on the very successful result.

The three sets of engines and dynamos, which were supplied by Messrs. Allen & Co., of Lambeth, the dynamos being Allen and Kapp's patent, worked in a most satisfactory manner.

The main switch-board, Scott's patent, engaged especial interest, and was much admired for its simplicity and compactness. It is specially arranged so that any one or more circuits can be run from any one of a number of dynamos; but no two dynamos can be put on to one circuit. On leaving the ship on Sunday afternoon, Mr. Scott was warmly congratulated by Mr. Lane, as well as by Mr. Hewitson, of the factory department, who both assembled the men of their respective departments to give him a parting cheer as he left the ship's side in the pinnace.

REVIEWS.

Electro-Deposition. A Practical Treatise on the Electrolysis of Gold, Silver, Copper, Nickel and other Metals and Alloys, with Descriptions of Voltaic Batteries, Magneto and Dynamo-Electric Machines, Thermopiles, and of the Materials and Processes used in every Department of the Art; and several chapters on Electro-Metallurgy. By ALEXANDER WATT. London: Crosby, Lockwood & Co., 7, Stationers' Hall Court, Ludgate Hill.

This work is by far the most complete treatise of the kind which has yet been published, and it is decidedly comprehensive. In the first 50 pages we have chapters on "Historical Review of Voltaic Electricity," "Electromagnetism—Magneto Electricity—Dynamo Electricity," and "Thermo Electricity," followed by a "Historical Review of Electro-Deposition." This last chapter is interesting and shows well the steps by which the important art has developed. The interest which amateurs have shown in the process of electro-deposition and electrotyping has always been strong, and much has been the consternation of *Materfamilias* on discovering her best silver spoons neatly plated with a deposit of copper by her youthful son. In speaking of Ohm's law we notice that Mr. Watt, abandoning the usual practice for no obvious reason, uses the symbol F to indicate current strength,

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giving the equation as $F = \frac{E}{R}$. On page 87 we find the extraordinary statement that a dynamo having an electromotive force of 1 or 2 volts and a resistance of 0·5 ohms, may give a current of 800 or 900 ampères!

The process of nickel plating, now become so common, is naturally very fully gone into; many of the formulæ which have been devised for the baths are very complicated and, as the author states, "almost takes one's breath away."

The deposition of platinum is considered, but the writing on the subject is, as usual, of the most vague description, and it is practically impossible to judge from what the author says whether such deposition is really possible. It is interesting to note from chapter xxx. the progress which the process of electrolytic copper refining is making, a progress due almost entirely to the important improvements which have been made in dynamo machines during the last few years; the author considers, and we agree with him, that in a very short period the art of electro-metallurgy will attain a far greater extent of development both at home and abroad. A noticeable feature in the book is a very copious index. We may add that the work is uniform with Noad's well-known "Student's Text Book of Electricity," and that it contains nearly 600 pages.

Berly's Universal Electrical Directory, 1886. London: W. Dawson and Sons, 148-9, Upper Thames Street.

This is the fifth annual edition of this publication, and the amount of care exercised in its revision is evidenced by its increasing accuracy and comprehensiveness. It is an additional satisfaction to find that while this improvement has been achieved, it has been found possible by judicious rearrangement to reduce both the bulk of the volume and its price. The determination to give the names of those only who are directly engaged in strictly electrical business, is a good one, and if rigidly carried out, will add value to the book as the "Electrician's Vade Mecum."

LEGAL.

The United Telephone Company v. Donohoe.—This was an action for an infringement of a patent, which the defendant admitted, and said he had only bought a few telephones in the London market in 1880, when telephones were commonly sold, and also eight in 1881 in the same manner, that save as to these he had not infringed the patent, and that he had written to the company undertaking not to infringe the patent again. Upon this the company applied to Vice-Chancellor Bacon for judgment, and the defendant did not appear. The Vice-Chancellor gave an injunction, but refused to direct an inquiry as to damages. The plaintiff company appealed, and Mr. Moulton, Q.C., appeared on its behalf and insisted that it was not bound by the defendant's statements (though the price of a pair of telephones was £20) and was entitled to an inquiry as to the numbers sold or purchased and the damages. [Lord Esher: Suppose they turn out to be nominal?] They can hardly do so on the defendant's own statements. But the plaintiff is entitled to an inquiry as to what the damages are. [Lord Esher: As to other telephones than those admitted?] Certainly; but at all events as to those admitted. [Lord Esher: He denies any others to have been purchased, and so you cannot take it as admitted that he has purchased others.] There is a right to an inquiry on proof of a single infringement. There are 10 infringements admitted here; telephones are sold in pairs, and the price of each pair is £20; that would make £200, and we believe there have been 20 or 30. It would be idle to put us to the expense of a trial where we shall have to prove nothing. The right to an inquiry is incident to an injunction. [Lord Justice Lindley: *Prima facie* so, certainly.] The defendant appeared in person. [Lord Esher said it was absurd for parties to appear in person; they could not understand the matters.] He had no means to retain counsel or pay damages. He understood the Judge to say that there was no case for damages; he had undertaken not to infringe the patent again, and thought the action oppressive. Mr. Moulton said the company had offered to him that he should make an affidavit that he had no further instruments, and he had declined to make the affidavit. He submitted that on the admissions made the company were clearly entitled to an inquiry as to damages. [Lord Esher: Your object is not to obtain damages from this man, which you cannot, but to find out others against whom you may proceed.] That is always the object. Telephones could easily be made, and if the usual proceedings could not be taken then the company's patent might be infringed with impunity and they had no protection. [Lord Esher: Suppose you are confined to the 10 instances admitted, would it be worth while to take the inquiry?] Certainly. [Lord Esher: Why, if you cannot get the damages from him?] He says so, but we are not bound by his statements.

Their Lordships having conferred together,

Lord Esher said as the plaintiffs took the admission of the defendant they must take it as limited to the 10 instances and must take it that there were no others, so that no inquiry could be gone into others. The plaintiffs, if they liked, might take the judgment for an inquiry so limited.

Lord Justice Lindley concurred, observing that the inquiry must be limited by the admissions.

Lord Justice Lopes also concurred. The plaintiff was entitled to an inquiry as to the 10 instances, but not as to others.

Lord Esher: The plaintiffs have failed as to part, and so no costs are to be allowed on the appeal.

In re The Maxim Weston Electric Company, Limited.—In the High Courts of Justice, Chancery Division, on Saturday last, a petition presented by the above company for the reduction of its capital was heard before Vice-Chancellor Sir James Bacon. The counsel who appeared in support of the petition, stated that the company owed no money to anyone, but had lost part of its capital, which was represented in the patents it owned. It was merely proposed to reduce the nominal value of the shares from 10s. to 5s. each. The petition also prayed that the words "and reduced" after the name of the company, might be dispensed with, having regard to the fact that there were no creditors. His Lordship granted the application in the terms of the petition.

Re The Pall Mall Electric Association.—(Before Mr. Justice Chitty, Saturday.) This, the petition of a creditor which came on before his Lordship in the previous week, and was adjourned in order that some arrangement might be come to, upon the application of counsel, was again ordered to stand over for a further period.

NOTES.

Electric Lights for the Stage.—On two recent occasions, by permission of Mr. D'Oyley Carte, "Iolanthe" was played at the Vestry Hall, Anerley. In the last scene a capital effect was produced by the electric light. The fairy Queen, "Iolanthe," and three of the fairies each had on her head a light of two candle-power with a reflector behind, the whole attached to a comb fastened in the hair. The Sentry had a lamp of greater power on his busby, and the Lord Chancellor, Lord Mountarat, Lord Tolloler, Strephon and Phyllis, each wore a small hair filament lamp mounted in artificial flowers. Each actor carried a small accumulator capable of running the lamp two or three hours. These accumulators were concealed about the person, and were not in any way found an inconvenience. The accumulators, lamps, &c., were those of Messrs. Woodhouse and Rawson, who have had considerable experience in this class of work.

The Electric Lighting at the Inventions Exhibition.—The electric lighting at the Inventions Exhibition, which, it is admitted, was one of the most attractive features of the exhibition, is said to have cost nearly £40,000.

Search Lights in the Navy.—The Admiralty has ordered that in future all large ironclads belonging to Her Majesty's navy, are to be furnished with not less than four electric search lights and mirrors.

Lighting Apparatus.—The Brussels correspondent of the *Times* writes that the Belgian Engineers' Association is preparing to hold, next month, an exhibition of all the various means of illumination hitherto used.

Electric Lighting in Russia.—During a grand Court ball at the Czar of Russia's Winter Palace, the vast halls of the palace were illuminated by electricity.

The Spiel Petroleum Motor.—We have ourselves had an opportunity of seeing this engine (illustrated in our other columns) in operation, and can testify to its satisfactory performance. There should be a great future for motors worked on this principle.

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A New Filament.—The Vitrite and Luminoid Company has been formed in New York, under the management of Mr. Theo. Mace, for the manufacture of what is known as the White incandescent lamp, but in the construction of which an entirely new departure has been made, a filament of a substance termed "erdite," a metalloid, being substituted for the ordinary carbon filament. It is claimed for the new filament that it does not blacken the glasses, and that its life is extremely satisfactory.

Electric Lighting in the United States.—Mr. Charles Lever has gathered the articles upon this subject which he wrote for the REVIEW, into pamphlet form, and we may safely commend the publication to those electricians who have not already read the articles in our pages, for it contains much that is original and interesting.

Electric Lighting in America.—The large number of electric light companies constantly being incorporated, says the *American Engineer*, shows the rapidity with which electricity is popularising itself. In one day the following companies were recently incorporated at Albany, N.Y.:—American Illuminating Company of New York, capital $300,000; American Illuminating Company of Brooklyn, capital $100,000; American Illuminating Company of Harlem, capital $100,000; American Illuminating Company of Yonkers, capital $30,000; American Illuminating Company of Long Island City, capital $30,000; American Illuminating Company of Newburg, capital $30,000; American Illuminating Company of Cohoes, capital $30,000; American Illuminating Company of Syracuse, capital $30,000; American Illuminating Company of Watertown, capital $30,000; American Illuminating Company of Ogdensburg, capital $30,000.

The Jablochkoff Company.—Last Friday, the 5th inst., there was a meeting of the creditors of this company at the offices of the liquidators, Messrs. Spain Brothers & Co., to receive the not very gratifying intelligence that they did not expect to be able to pay *one penny* in the £. We are indebted to a correspondent for the information which follows. The capital of the company was £195,000; £100,000 in fully paid up stock went to the promoters, £55,000 in cash was paid for patents, and £40,000, in addition to £11,000 owing to the creditors, has been expended in the "operations" of the company. Shortly before the liquidation the whole assets of the company were mortgaged to some of the directors for £4,200. Three of these mortgagees are directors of the new company, to which the patents, plant, stock, &c., of the old company were sold for £6,200. We believe these gentlemen took their £4,200 in the new company in shares, and the £2,000 they paid the liquidators in cash has been spent in liquidation expenses and in "protecting the interests of the company until the new company purchased." No balance sheet was produced, and the various points had to be elicited by questions from the creditors.

Work for the Unemployed.—Lord Thurlow, at the meeting of the Anglo-American Brush Electric Light Corporation on Wednesday, stated that he had made a calculation which showed that the passing of the proposed amendments of the Electric Lighting Act of 1882 would provide work in London alone for upwards of three years of more than 10,000 men, at an expenditure of £6,000,000 sterling. Lord Thurlow surely does not expect to see such a scheme immediately realised; what then is the object of raising hopes which may not be fulfilled for generations to come?

Electric Lighting in Oxford Street. — Messrs. Haywards, an old-established lace firm in Oxford Street, are having their premises fitted with the electric light. The installation, which is to consist of 1 arc and 120 incandescent lights, has been entrusted to Messrs. Craven and Elworthy.

The Electric Lighting Act.—It is stated that had the late Conservative Administration remained in power, Mr. Stanhope, the President of the Board of Trade, would have introduced a Bill for the amendment of the Electric Lighting Act of 1882, extending the period before the compulsory purchase clause would come into operation from 21 years to 40 years. Lord Rayleigh's proposed Bill, we believe, excludes this compulsory purchase clause altogether, on the ground that the gas industry was not at its outset hampered by any such restricting condition.

"The Electric Light in Workshops."—Mr. Charles Lever has published a pamphlet with this title, which he prefaces with the remark that it is not intended to instruct electricians; but rather to give engineers and others having large workshops some information in regard to the development of the arc lamp, for he thinks there is no form of artificial illumination which so well fulfils the requirements of workshop lighting. We think it will be found to admirably suit the purpose for which it is intended.

Electric Lighting in Milan.—The electric light installation in Milan is now probably the largest of the kind in the world. At the end of last year there were in use five boilers of 164 horse-power each, and six dynamos of the Edison "C" type, equal to a capacity of 1,000 16-candle-power Edison lamps each. This has now been increased to six boilers of 164 horse-power each, and two new dynamos, besides a small dynamo equal to 400 lamps, for day and night work. The total number of incandescence lamps at present in use amounts to nearly 8,000, besides which there are over 70 arc lamps at work, and 30 more in course of installation.

Skating Pond Lit by Electricity.—During the skating season the large loch at Cambuslang, near Glasgow, was brilliantly lighted by means of three Crompton D D arc lamps, of 3,000 C.P. each, supplied by current from a Crompton-Bürgin machine. The loch was crowded each evening, and as the skaters glided by under the rays of the powerful lamps, the scene was gay and picturesque in the extreme. The lighting was carried out by Messrs. Henry Bennett & Co., of Glasgow, and we may mention that since this firm first added the electric light department to their business—more than six years ago—they have each year lighted up one or other of the skating ponds in the neighbourhood of Glasgow, and always with the most gratifying results.

Electric Lighting at the Edinburgh Exhibition.—Messrs J. D. F. Andrews and Co., of Glasgow, have been allotted the lighting of a large portion of the International Exhibition to be held in Edinburgh in the coming season. They will put in 34 Andrews arc lamps supplied with current from two Andrews patent dynamo machines. One powerful Andrews arc lamp will also be erected on a mast 80 feet high, in the court yard of Old Edinboro'. The other lights will be distributed throughout the machinery and motion departments of the exhibition.

The Bell Telephone Patents. — The New York *World*, whilst approving the decision of Secretary Lamar to recommend the Government to commence suit against the Bell patents, counsels the Attorney-General to get rid of his large holding of rival telephone shares, asking him whether he considers his ownership of this stock is calculated to raise the highest standard of official honour in public life.

The Telephone in Scotland.—Mr. A. R. Bennett last week attended a meeting at Dunfermline to advocate a scheme for connecting Glasgow to Dundee *viâ* Falkirk, Stirling, Alloa, Dunfermline, Burnt Island, Kirkcaldy, and Cupar, and to that end the opening of an exchange at Dunfermline. Promises of support were given by the Provost and others, and there is every probability of success.

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The Plymouth Telephone Exchange.—The Three Towns Telephone Exchange at Plymouth has received some important additions of late to its list of subscribers. The Mayor has had his private residence connected, but an addition which will act as a convenience to a very large number of persons is that of the Plymouth Club, whose members can now communicate with any member of the exchange. The "call" offices at Plymouth, Mannamead, and Devonport are not made use of so generally as might be wished, but this is probably owing to the advantages attending them not being sufficiently well known. The exchange now numbers nearly one hundred members, and it has been suggested that there should now be an extension of the hours during which the exchange is open, as it is considered that this would result in many private residents becoming subscribers, so as to be able to converse with their friends during the evening after arriving at home from business. This would be a great benefit to medical men, in frequently obviating the necessity for a second visit. The expense attending the extension would not be considerable, and we have no doubt that the company, willing as it always is to meet the requirements of the public in every possible way, will see what can be done to carry out the suggestion.

Telephonic Communication for the Plymouth Police Stations.—The Watch Committee of the Plymouth Town Council has decided to recommend that an agreement be entered into with the Western Counties and South Wales Telephone Company with the view of affording communication by telephone between the central and branch police stations. The importance of this recommendation is such that it can only be a matter of wonder that it was not thought of before; but probably the recent disastrous fire has had the effect of quickening the faculties of the local Conscript Fathers.

Cable News.—We notice that the ss. *Silvertown*, and the ss. *International*, belonging to the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, have returned to the Thames. The first named vessel has been engaged in laying, under contract with the French and Portuguese Governments, telegraph cables along the West Coast of Africa. The system now extends to Conakry, a French settlement, some 80 miles to the north of Sierra Leone. Among the sections laid during this last expedition was a cable from the Cape Verde Islands to the West Coast, thus duplicating the communications. Cable, for the continuation of the undertaking under contracts with the same Governments, is being rapidly manufactured at Silvertown, and it is expected that within a very short period the company's ships will again leave the Thames for the West Coast. Meanwhile, the ss. *Buccaneer*, is actively engaged in sounding along the coast, and has already prepared the way over a considerable portion of the route. We hope on a future occasion to lay before our readers a more detailed account of this important enterprise. The ss. *International* has been engaged with the ss. *Dacia*, in laying cables for the Indian Government in the Persian Gulf. The successful completion of this work has already been noticed, and judging from the tone of official reports, we must congratulate the Silvertown Company on the manner in which the work has, from first to last, been executed.

Saved by the Commercial Cables.—The *New York Herald* of January 30th, contained the following:—"Communication between Europe and this country would have been entirely interrupted for many hours yesterday had it not been for the Mackay-Bennett direct New York cable *viâ* Coney Island. All of the cables of the old lines were working slowly and unsatisfactorily. It would be impossible to estimate the extent of the inconvenience and loss which would have resulted to the financial and business world had communication been entirely closed during Stock Exchange and business hours."

The Cable Record Beaten.—According to the *New York Herald*, one of the leading firms of arbitrage brokers in New York sent a message on the morning of the 28th ult. from the Stock Exchange office of the Mackay-Bennett Cable Company to London. The business referred to in the message was transacted, and the answer received in New York in the space of *six minutes;* the quickest time on record.

Telegraph Revenue.—The receipts on the telegraph service from April 1st, 1885, to February 6th, 1886, amounted to £1,480,000, against £1,490,000 received from April 1st, 1884, to February 7th, 1885.

Almanacs.—We havo this year received the following almanacs:—"The Engineers' Almanac," compiled by Mr. Edwin Bennett, manager to Messrs. Pfeil & Co., which contains a great deal of information relative to the construction and launching of notable ships; one from the Lancashire and Cheshire Telephonic Exchange Company, containing cuts of telephonic instruments, and information interesting to intending subscribers to the exchange; and an effective advertisement almanac from Messrs. Hudswell, Clark & Co., through their London electrical agents, Messrs. Heap and Stuart.

The West End Riots.—Mr. Eric Stuart Bruce, M.A., well known to our readers as the inventor of a balloon-signalling system, was among those who were interfered with by the riotous mob at Hyde Park Corner on Monday. Mr. Bruce was in a hansom cab with his wife, when a large jagged stone, which must have been brought some distance, was hurled through the window, covering the occupants of the cab with broken glass. They experienced a narrow escape from serious injury, and Mr. Bruce writes to the *Times* that he thinks it showed a want of foresight and vigilance in the police authorities not to have taken extraordinary precautions, seeing that a breach of the peace had been threatened.

Lighting up a Thighbone.—An interesting surgical operation was recently performed at the New York Post Graduate Medical School, in which electricity played a very important part. Disease was suspected in the hip of a young man of 22, and the doctors introduced a small drill, or electric-osteotome, into the bone, gradually with its aid cutting away the diseased portions, in order to see which, a tiny electric lamp, no larger than a pea and with a filament as fine as a hair, was placed in the hole in the bone and "flashed up" at intervals of a few seconds, the filament being so fragile that it could bear the current only for an instant at a time. It is said that the light made the interior of the bone as clear to the eye as if it were laid open on the dissecting table.

Committal of an Electrician.—Charles Stewart Cochrane, the American electrical engineer against whom the charge of forgery and personation was a month or two since brought, was on Monday sentenced to 18 months' imprisonment with hard labour.

A Disclaimer.—The Electric Apparatus Company, Limited, of Queen Victoria Street, asks us to state that it has no connection with a firm in Queen Victoria Street which advertises the sale of a portable reading lamp. The company has had several applications for this lamp and wishes to correct any erroneous impression that may have been created in the minds of the public.

Tenders for Electric Lighting Wanted.—Messrs. Elder, Dempster & Co. advertise for tenders for the electric lighting of their offices at 14, Castle Street, Liverpool. Tenders to be sent to 48, Castle Street. The Northfleet (Kent) Local Board desires tenders for lighting the streets of the town by gas, oil, or other illuminant. Tenders to be delivered to Messrs. Sharland and Hatten, Court House, Gravesend, by the 17th inst.

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Trotter's Dioptric Glass.—Messrs. Woodhouse and Rawson have been appointed by Mr. A. P. Trotter special agents in Great Britain and the Colonies, and sole agents on the Continent, for the sale of his patent dioptric glass.

Dynamo Testing.—Mr. Charles F. Heinrichs discourses in the current number of the New York *Electrical Engineer* on the tests and efficiencies of dynamo-electric machines. He thinks that the most accurate results can be obtained with such a transmission dynamometer as that of the Royal Agricultural Society, in conjunction with a Prony brake. He concludes a long and interesting article by suggestions as to what should guide a committee of experts in making awards.

The Franklin Institute Tests. — A considerable amount of correspondence on this subject is to be found in the columns of the New York *Electrical World*. Mr. Heinrichs, who started the discussion by throwing doubts upon the accuracy of the horse-power measurements made with the Tatham dynamometer, comes in for severe criticism from Prof. Marks. of the Franklin Institute, and Mr. Geo. B. Prescott, Jun., of the Weston Laboratory, Newark, N.J. This latter gentleman, who writes at great length, has not yet learned the art of making the "retort courteous," and he goes out of his way to make personal allusions which are not arguments.

Alternating Currents.—Mr. Max Deri deserves much credit for his endeavours to show that alternating currents are, after all, more sinned against than sinning. His lecture, the first portion of which appears in our other columns, forms an interesting addition to the writings on alternating currents.

Lecture.—Mr. J. Jerritt, of the Society of Telegraph Engineers, gave an interesting series of experiments in electricity before the members of the Miners' and Mechanics' Literary Institution, St. Agnes, Cornwall, about a fortnight ago. Mr. Jerritt has kindly consented, at a future date, to give an entertainment on a larger scale in aid of some deserving local fund.

The following letter written to the *Cornishman* of January 30th, will give some idea of the subjects dealt with by Mr. Jerritt :—Deer Maister Editur,—Aw, my, wonders wull nevver cese! We've hed some friteful doens heer—for St. Ann's: iss, gashley things do happen now-a-days, fur I seed thet up to Menhennit theer's a poor wummun hev had three childern all to wance! I spose she'll git three suvverins from the Queen 'pon her thrown. And theer's a gashley man heer to. He do belong up to post-office, and was up to our reading-room, and fritened haalf the men and wummen out ev theer lives the other evvenin. I, and Josey, and the boy Tom (down Dirty pool) ded'nt think theer was no harm to go and see un, or we shud nevver hav gone. I wesh I hed'nt, for the cow had calf while I was away and Goorge was poorly, semmin, and cud'nt tend ur. Howsomevver we cum up, and seed un long side ov Docter. A long slivery chap a was to, clean shaved all but his stauche, and up to enny wickedness. Thet es so fur as we ken see, for the table avore un wos covvered with aal kinds ov instrummints an things thet seemed like the fire enguns they had in to Truraw to Maister James place, when a was burnt down, and t'owld things then wud'nt skit t'all. Howsome ever Dokter get up and sed few wurds for un, and then ee begin. Ee turned round and pecked up poker frum the graite, and stick un pun back ov a cheer, lor! t'was clevver to make un bide thare, as won es a dun that ee rubbed bit broun paaper under es arme and held un fore to the poker, and tha gashly owld thing cum arter un, and vallod down pon planchen and was boughed uncommon: sure I don't knaw what Maister Sam do think bout et. As soon es ee dun that he shawed what a called the elektrik magnit, ee hed poundsof filins from down Foundery and bit paper, an put this magnit under an maade they filins march bout like riggiment sodgers as was down Camberne for lecshun. Next he shawed elektrik lite, twas a raal lamp weth no oil or weck, an a put a cupple ov copper wires to un an set un all avire. Then we had telegram all round tha world and whot ee called galvanec machine, by shoks given how they chaps as clinched they wires screeched, but this man tuk care not to howld on hisself to they. Then a hed a little bell, morn a fathom away from um, and he put his hand down pon the table and ring un to: I was getting frightened, I was: and then, my lor, he fired of a grate cannun to, and sed twouldn't frighten us, but ded you, and smilled bad just like they that fire at craws and kill pigguns. Iss sure, smell powder was bad, and we boys back behind was glad enough to see Maister Konjurer set down. Well, sir, Maister Dick an Rejayster said nice things about un, and so ded we, cause we dednt like to say nothin else, an then he took his things away. I do heer ees goin to do liken agen, but I shaant go, tes to gashley: a man that cud do that wud rob a bank. I daresay that I'll rite and tel ee somethin bout wot he do do next time, ef I ken make up my mind to go an see un.—Yours respeckfuly, JAN TREGURLA.—*P.S.*—After aal I hav not told ee Maister Konjurer's name: tes MAISTER J. JERRITT, and he do cum from Plemmoth.

Electric Speed Indicator.—Writing to the New York *Electrical World*, Mr. G. B. Prescott, jun., says:—"An ingenious speed indicator recently devised by Dr. Th. Horn, of Leipsic, Germany, and described by the inventor in a late issue of the *Electrotechn. Zeitsch.*, is the subject of an interesting note in The *Electrical World* of December 19th, 1885. This note is reprinted in the January 1st number of the London TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW. The instrument referred to is based on Arago's experimental demonstration (1824) that a revolving copper disc causes a magnetic needle placed above it to rotate in the same direction. A speed indicator acting upon this same principle was invented by Mr. Edward Weston in the latter part of the year 1882, and is the subject of U.S. patent No. 277,179, granted May 8th, 1883. The only difference between Dr. Horn's recently invented indicator and the indicator patented by Mr. Weston several years ago is that, whereas in the former instrument the disc, or rather its equivalent, the ring revolves, and the directive force of the needle is obtained from a magnet, in the latter instrument the needle revolves and the directive force of the disc is supplied by a spring."

The Proposed Trans-Pacific Cable.—The *Colonies and India*, in an editorial upon this subject, says:—"We have no information as to the representative character of the gentlemen who are moving in the matter of the proposed Trans-Pacific Telegraph Cable, but it is probable that the movement has originated in Queensland. In a recent speech in the Legislative Assembly of Queensland, Sir Thomas M'Ilwraith drew attention to the existing telegraph rate of 10s. 10d. per word, which he characterised as 'monstrous,' and after deploring the fact that Queensland was not represented at the late Telegraph Conference at Berlin, he went on to advocate the construction by Queensland of a 'line of her own,' pointing out, however, that the difficulty lay in the hopelessness, if not the impossibility, of reducing the charge between England and India. From this point of view it is obvious that the best way to meet the difficulty is to adopt an entirely different route, and the best that could be chosen is that *via* North America. The Atlantic cable companies would no doubt be glad to secure an accession to their present business by agreeing to take through messages to and from Australasia at a reduced rate, and in that event the monopoly of the Eastern Telegraph Companies would be broken down, and telegraph rates to Australia would be brought to a reasonable figure."

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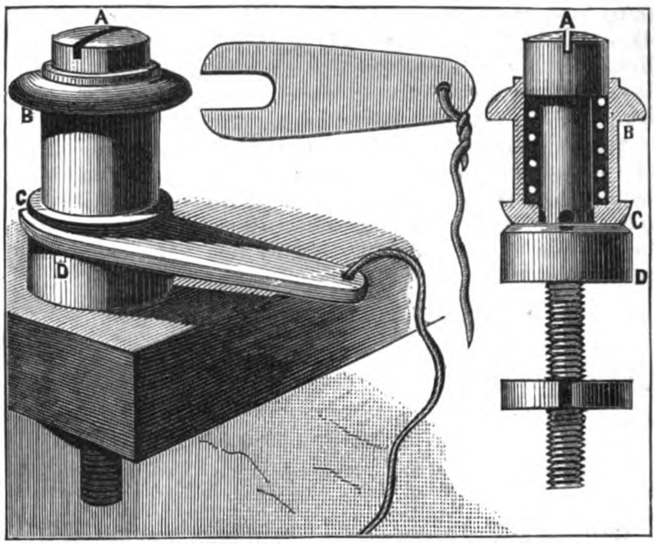
Long Electric Light Circuits.—Writing to the New York *Electrical Review*, Mr. J. R. Johnston states that the Rock Island County Brush Electric Light Company has at Rock Island, Ill., a circuit 15 miles long, operating 50 arc lamps of 2,000 C.P. each. The line or circuit is arranged in two divisions and operated by one No. 8 Brush dynamo, either separately or jointly, as circumstances require, each division having a switch board at or near the dynamo. One division is called the tower circuit, comprising 11 towers 132 feet high. This circuit is constructed of No. 6 wire, Stubbs gauge, and carrying 25 double lamps. The other division is called the store circuit, and on this are 25 single lamps. The dynamo is driven by a walking-beam engine of 45 horse-power, making about 60 revolutions per minute, with countershafting that gives the armature a speed of 750 revolutions. This plant has been in successful operation for three years. It has also been a success financially.

Re Andersen's Formulæ.—If the correspondent who writes us upon this subject, and signs himself "Ohm," will send us his name and address (not for publication) we will insert his communication. We cannot publish anonymous contributions.

Type-setting by Electricity.—Mr. J. E. Munson, a stenographer, of New York, is said to have invented a machine for setting type by means of electricity. According to the description in the New York *Sun*, a tape is punched in a manner similar to the punching of the tape of a telegraph instrument, and this tape is placed on a roller in the type-setting machine, and passes under a row of 10 steel fingers. The roller is connected with a battery. As the tape passes over the rollers the fingers find the rows of holes and drop into them. Each finger is connected with a magnet, and each magnet with one of 10 narrow steel plates that keep a series of pointers from reaching the type in the reservoirs. When a row of holes in the tape representing a character passes under the fingers, the fingers above the holes drop down on the cylinder, a current of electricity passes to the magnets, and the magnets, thus influenced, draw such a combination of the little plates from one side of their normal resting place to the other as will allow the pointer opposite the required letter to reach the type in the reservoir and force it into the shoot leading to the "stick" which is to hold it. The impulse given to the pointers is simultaneous with the action of the magnets. When the tape passes on, the plates and pointers return, until another row of holes in the tape is reached, and then the action is repeated.

The Divining Rod again.—A correspondent sends us the following cutting from a New Zealand paper, which he thinks may amuse our readers :—"A gentleman from the West Coast waited at the Christchurch Press office, in December last, to exhibit a new electrical divining rod. For this modern invention all the powers, and more, of the ancient magical rod in detecting gold anywhere were claimed. The rod was an arrangement of wire cased in leather, something like a huge spur, the divining rod being nicely balanced across the half-circle so that one half was outside and formed what might be termed the rowel. Attached were bottles containing gold and electricity. The gentleman from the West Coast tried the rod with a representative of the Press on some gold and silver coins, and sure enough the rod dipped over the gold coin infallibly. The Press representative tried it, and he also succeeded, as the rod "dipped" over the gold. But the representative of the Fourth Estate was not quite satisfied, so he rolled three sixpences and a half-sovereign in paper and laid them about the room in positions unknown to the gentleman from the West Coast. The divining rod was tried, but here it was decidedly at fault, for it did not respond to the gold, but did to the last of the silver coins. The gentleman from the West Coast departed, with a request that nothing should be written concerning the matter, as it was evident that if the rod could not detect gold when rolled in paper, the claims of its inventor that it would "dip" when walking over a spot on any hill where gold was concealed in the earth, were open to question."

M. De Combette's Automatic Terminal.—Ordinary terminals with a screw or a hole present certain inconveniences in cases when numerous experiments are made, or when it is requisite to be able to rapidly substitute one apparatus for another, to alter wires, &c. This terminal, which we reproduce from *La Nature*, has a central piece, A, resting upon the base of the apparatus by a flange, D, and a movable portion forming a hollow cylinder provided with a milled head, B, at the upper and with a flange, C, at the lower end. An internal spring keeps the flange, C, pressed strongly against the base. By resting the thumb upon A, and taking the milled head between the index and middle



fingers, we raise the movable cylinder. We can then insert between C and D a looped wire, or a slotted plate previously soldered to the wire to be connected. On releasing the terminal the spring grips the wire or plate, and ensures a sufficient contact when the parts are quite clean. This terminal may be used for experiments at meetings and lectures for medical, telegraphic and telephonic apparatus, &c., and in all cases where we require to establish communication frequently and rapidly between electric apparatus.

NEW COMPANIES REGISTERED.

Standard Time and Telephone Syndicate, Limited.—Capital £20,000 in £1 shares. Objects:—To acquire and work inventions for the regulation of time by electricity or otherwise, for the transmission, accumulation or dispersion of electric currents, and for the utilisation of electricity. To manufacture telephones and to establish telephone exchanges and to manufacture electric, magnetic and pneumatic apparatus of all kinds. Signatories (with one share each):—C. E. Haefling, 143, Sandringham Road, Dalston; J. Negus, 38, Roseberry Place, Dalston; J. A. Hilliard, 75, Cornhill; E. Shirley Parker, 75, Cornhill; S. H. Newman, 7, St. Quintin's Avenue, North Kensington; J. Wallis, East End, Finchley. The direction of the company will be vested in managers who are to be appointed at the first general meeting. The remuneration of the managers will be such sum as may be voted at the annual general meeting. Registered 6th inst. by Stretton and Hilliard, 75, Cornhill.

Gas and General Works Company, Limited.—Capital £10,000 in £1 shares. Objects:—To construct and maintain public works of all kind in any part of the world, including railways, tramways, harbours, docks, gas works, telegraph and electric works, and works for the supply, use and application of electricity

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for light and power. Signatories (with one share each): James Clegg, W. Harwood, Wm. Hoyle, A. Clegg, A. S. Marshall and P. Clegg, all of Accrington, Lancashire, and J. H. Hole, of Cheetham, Manchester. Directing qualification £100 of capital. The signatories are to appoint the first directors. Registered 8th inst. by Mr. J. Chamberlain, of 5, Trafalgar Terrace, Moseley, Lancashire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Standard Time and Telephone Company, Limited.—At an extraordinary general meeting of the members of this company, held on the 18th ult., at 19 and 21, Queen Victoria Street, it was resolved to wind up voluntarily. The resolution was confirmed on the 2nd inst. and duly registered on the 6th inst. The company was incorporated on the 26th July, 1882, with a capital of £100,000 in £1 shares. The only return filed is made up to 24th November, 1882, and shows that 20,085 shares were taken, and upon these £18,057 had at that date been paid up.

West African Telegraph Company, Limited.—The statutory return of this company, made up to 2nd inst., was filed on the 6th inst. The nominal capital is £1,000,000 in 100,000 shares of £10 each. 2,000 shares have been taken up but no call has yet been made thereupon. Registered office, 106, Cannon Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Telegraph Company, Limited.

The ordinary general half-yearly meeting of this company was held at the Cannon Street Hotel, on Friday, last week, under the presidency of the Right Hon. Viscount Monck, chairman.

There was a large attendance of shareholders in anticipation of the discussion on the subject of the renewal fund, and the motion of which notice had been given, that no further additions be made to that fund with the exception of the accruing interest.

Mr. T. H. Wells, the secretary, having read the notice convening the meeting, and the minutes of previous meetings having been read and confirmed,

The Chairman said that when he last addressed them he was obliged to tell them that several, if not all, of their short cables on the other side of the Atlantic had suspended action. They were aware that, independently of the cables which carry the traffic of the company across the Atlantic, they had a regular system of cables at the other side connecting the cables with the different seats of traffic in America. He had now the pleasure of telling them that those cables, and the whole of the rest of the system, were in perfect order and working with efficiency. There was not a single mile of the plant that was not complete and in perfect order. Having said that, he was sorry he could not give them a very satisfactory account of the traffic itself. The competition still continued. The truth was, that the public, in their wisdom, had put down in the Atlantic such a number of telegraphs that at present the traffic did not afford a living to any of them; and his belief was, that it could not afford a living to any of them without one of two things occurring. One relief might, of course, be obtained by a very large increase of the traffic, but he was sorry to say that, after the experience of nearly twenty years, having tried tariffs of all sorts, high and low, they could not find that there was that elasticity in the traffic which would enable the number of cables now existing in the Atlantic to live. The elasticity of the traffic was, he thought, completely exhausted unless there was a return of prosperity and trade. The only other alternative was one the public would not desire adopted, but it was one which he had ventured to declare from that place, would be the result of the inordinate competition which prevailed—and that was, the rates must be raised. There was an old saying that where combination was possible competition was not likely to continue long, and seeing the small number of people it was necessary to bring into agreement, his belief was that the rates would be raised to a paying figure. They had been hoping and expecting that this would take place for some time, and even now he could not help thinking that the time was not far distant. The gentlemen who placed the last two cables in the Atlantic were American gentlemen of great wealth, but they had absolutely no experience of telegraphy. They all knew that on this side of the Atlantic people were obliged to be satisfied with a very moderate rate of interest on their investments; but that was not the case on the other side, where they required a much larger rate before they were satisfied, and he believed those gentlemen, after the experience they would have acquired by the last year's transactions, would not be much gratified with the return which the large outlay they had made on those cables would bring them in. He could not help thinking that before long that consideration would bring them to a state of mind which would make them listen to reasonable terms. At all events, if things did not take that course, this company had always the power of drawing the sword. There was a limit to forbearance. They were unwilling to throw away more money in a battle of rates, but, if necessity arose, it would come to that at last. If they had to go to a battle of rates they were in a very good position to carry it on. They had a perfectly efficient plant, and they had also a very large reserve fund at their back. Going to the accounts, the chairman said it was the duty of the directors, at a time when the receipts were coming in but slowly, to do their utmost to economise in the administration of the affairs of the company. Accordingly, economy had been exercised in almost every item of expenditure in the last half-year, and there was a reduction throughout, beginning with the expenses of the head office in London, £221. The difference between the working expenses abroad for the half-year, and those of the corresponding half-year in 1884, was very large—£4,800; but it was only right to mention that that reduction was due to the cessation of some extraordinary expenses in the last-named half-year; still, there was a substantial reduction in the expenses of the half-year. The repairs to cables, which related to the state of things to which he alluded at the beginning of his remarks, cost, during the last six months, £11,376; consisting of the expenses of the *Minia*, £10,417, and the cost of the cable used, £958. The vessel was not engaged in repairing this company's cables the whole of the half-year, but was chartered to other companies for the repair of their cables, obtaining thus £10,270 sterling, so that in point of fact this company's repairs were effected at very little more than the cost of the cable expended in the operation. He came now to say a few words on the great subject of debate in that room, namely, the renewal fund. They had all probably seen in the papers an account of a meeting of shareholders in reference to this subject. These gentlemen met some fortnight or three weeks ago and appointed a committee, which committee asked to have an interview with the board. The board was not at all above adopting a good precedent—that afforded by the joint action of the two political parties in passing a recent measure of importance—and at once acceded to the request. They would remember that at the last half-yearly meeting the board determined to reduce the contribution to the renewal fund from £150,000 to £100,000 a year; that was to continue for three years, after which the sum was to be still further reduced. After conference with the committee at the beginning of the week, the board came to the decision that as soon as the renewal fund had reached the sum of £1,000,000 no further addition to it should be made for renewal, and that the only sum that should be added after that period should be the interest on the fund itself. That resolution was accepted by the committee as satisfactory. He must state, however, that the resolution was conditional on no breakdown taking place within the next year, for, of course, if any of the cables broke down, it would have to be replaced, and they would have to reconsider their position. Mr. Smith of York, who had led the opposition, had expressed himself satisfied with the decision of the directors and had authorised him (the Chairman) to say that he would not put the resolution of which he had given notice. In his letter, Mr. Smith asked for something further; he asked that the directors should give an engagement that no larger sum than £100,000 should be expended from the renewal fund without the sanction of the proprietors. Well, that involved an infraction of the articles of association, and it could not be done; Mr. Smith's object could not be carried into effect without an alteration in the articles of association. Would they allow him, in all good faith and kindliness of feeling to ask them what necessity there was for such an engagement. Their object could, of course, be seen, and a very just object it was; it was that the renewal fund should only be expended for the purposes for which it was created. Well, what had been the history of that renewal fund? When he (the Chairman) first became connected with the company, they had the '65 cable, the '66 cable, and the French cable. Immediately after the junction between the Anglo-American and the French companies, they laid another cable, which was laid partly with the material which had been provided by the French Company for duplicating its own cable. Immediately after the junction of the two companies they began to accumulate the renewal fund. Therefore none of the cables laid before that period could have been paid for out of the proceeds of the renewal fund. Presently the '65 cable gave out, and by the terms of their agreement with their allies in the pool transaction, they were bound to replace that cable. Fortunately, they had a considerable quantity of material which was to have been laid by the French Company in laying their cable, because the cable this company put down from Ireland to Newfoundland was not nearly so long as that for which the French Company made provision. Therefore, after the '73 cable had been laid, a large part remained and was used to partially replace the cable that broke down, the remainder being provided from renewal. Therefore, the only expenditure which the renewal fund had made up to that time was in repairs, and in assisting in the laying of the cable of '74. Afterwards the '66 cable gave out, and a new cable was laid exclusively out of the renewal fund. They all admitted that the renewal fund was intended to replace the property already existing, and for nothing else. He could assure them that up to the present they had not spent a shilling for any other purpose, and what right had the shareholders to assume that they would do in the future what they had never yet done? Mr. Smith spoke in very flattering

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terms of the whole of the present board, and appeared to think all would be well if they could secure immortality. But it seemed to him (the Chairman), that if they were succeeded by another board not so scrupulous, any shareholder could obtain an injunction to prevent the application of the fund for any other purpose than that for which it was created. This being the case, what reason was there in changing the articles of association, discrediting the directors, and thus bringing discredit on the enterprise itself? The board had considered the subject very carefully, and for the reasons he had given could not assent to Mr. Smith's proposition. He concluded by moving the adoption of the report and the declaration of dividends of ½ per cent. on the ordinary stock, and of 1 per cent. on the preferred stock, making 1¼ per cent. on the former, and 2½ per cent. on the latter for the year ended December 31st last.

Lord Tweeddale seconded the motion.

Mr. Chester asked for the results of the whole year's working of the *Minia*; the chairman had only given the half-year's working.

Mr. Thomas Smith said he thought the shareholders might congratulate themselves that they had now seen the end of the additions to the renewal fund, and that from the 31st December of the present year they would have the use of the net earnings. He might say that his lordship had made a slight mistake. The arrangement come to at the conference was that at the end of the present year no further addition than £100,000 should be made to the renewal fund, and that it should be made up by the interest. The committee trusted the shareholders would accept the arrangement with satisfaction as ending the drain on their resources and leaving for future contingencies the immense sum of £1,000,000. This was a grand backbone, and they had now only to be watchful with regard to the spending of it. He had for some years been compelled to oppose the adoption of the directors' reports; but the directors having now made what he considered a satisfactory statement as to any further additions to the renewal fund, he had much pleasure in supporting the adoption of the report now before them. He did not undertake, however, to blindly follow the directors in whatever they might propose; as in the past, he should in the future, as a man of business, reserve the right to think and to act upon his own independent judgment.

Mr. Chipperfield asked the cost of the last cable.

Mr. Weaver (managing director): Something over £400.000.

Mr. Chipperfield also desired to know what the Mackay-Bennett cables cost. When the renewal fund was started the cost of laying a cable was much greater than now, and the amount necessary to be annually set aside was consequently now much smaller. Were a cable to be laid across the Atlantic now it would not cost £400,000.

Mr. Weaver: Oh, yes it would; £400,000 was the money we spent on the last cable, but there were shore ends of the old cables which were used.

Mr. Chipperfield contended that if the contemplated additions to the renewal fund were made, a sufficient sum of money to put two, if not three cables across the Atlantic, would have accrued.

A Shareholder said they were very glad the matter was already settled; and now they wanted to know how much the committee were out of pocket by their exertions, for they should not be allowed to lose anything, as they had been acting in the interests of the whole of the shareholders.

Mr. Garner protested against that part of the chairman's speech regarding the war. They had nothing to do with other companies. It was for them to work as cheaply as the others, and cheaper if they could. The result of previous "wars" had been that a combination followed, and another company started. But for their adoption of this course they would have had a monopoly, and the whole affair would have been in their own hands.

Mr. Weaver: You would have had no dividends.

Mr. Chester differed from the chairman's remark respecting the elasticity of the traffic, and spoke hopefully of telegraphic communication in the future. He then strongly argued for an alteration in the articles of association, which, he believed, would allow the board to purchase the two cables of the Commercial Cable Company, using portions of the renewal fund for the purpose.

Mr. Stockdale, Mr. Newton, Mr. Jackson, and Mr. Parker having spoken in the same direction,

The Chairman, replying to the remarks made, said Mr. Stockdale was wrong in saying the renewal fund was invested in the names of two members of the board; the securities were in the name of the company, and could only be altered by a resolution of the board under the seal of the company. Rather a false construction had been put upon his use of the word "backbone" in reference to the renewal fund. He merely meant that when they had a renewal fund that would replace all their plant, they might be at perfect ease as to the result of any contest with competitors. He did not mean that that money could be employed directly in conducting the contest. It would be gross malversation if they did use it in that way. The last cable laid cost in money £430,000, but, in addition to that, they had the shore ends of the old cable to make use of, and he thought he was within the mark in saying that that would have brought the sum to £500,000. The total receipts for the whole year from the *Minia* amounted to £26,228 9s.; she was chartered by other companies during the year to the extent of £16,430, leaving a balance of £9,798 9s., which represented the whole of the cost of the repairs during the year, as far as the ship was concerned. They had had a good deal of discussion, but all had been of such an amicable nature that he did not feel it necessary to trouble them with any further observations, and would therefore put the resolution.

The resolution for the adoption of the report was then put and carried unanimously.

The Chairman and Mr. Wm. Barber were re-elected directors, and the auditors, Messrs. Joshua Deane and Francis Glass, were reappointed, after which votes of thanks to Mr. Thomas Smith and the Chairman and directors were passed and acknowledged.

Anglo-American Brush Electric Light Corporation, Limited.

THE fifth ordinary general meeting of the shareholders of this corporation was held at the Cannon Street Hotel, on Wednesday, the Rt. Hon. Lord Thurlow, presiding.

Mr. E. Garcke, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, congratulated the shareholders on the improved aspect of affairs, which enabled the directors to recommend the payment of a dividend, a small one, it was true, but one honestly earned during the past year. The position to which they had been restored had not been attained without considerable anxiety on the part of the board and the members of the staff. Having thanked the shareholders for their unremitting confidence, the chairman proceeded to state that the affairs of the corporation now rested on a very strong foundation. The works in Belvedere Road had been fully employed in the execution of good orders during the whole of the year, and the volume of work executed was in excess of that of the previous year by nearly 25 per cent., the net profits of the two years bearing as nearly as possible the same relation. The profits of 1885 would have been much larger but for the extravagance of their predecessors, and the fact of their being hampered with an establishment and premises which were still far beyond their manufacturing requirements; but in the face of the increasing volume of business they did not see how they could now profitably reduce either the establishment or the works. They were now executing a large quantity of genuine, sound and paying orders, which would carry them on for nearly twelve months. These orders were received from Government, from various colonial departments, and from manufacturing firms in England, and for lighting the impending exhibitions at Liverpool, Edinburgh, and Folkestone. A very satisfactory feature was the regularity with which the orders came in, from one quarter or another, and this had enabled them to constantly and fully employ, and sometimes to employ in overtime, 300 men at the works; to these 300 men he took the opportunity of tendering his thanks for the intelligence and zeal which they had displayed in the service of the company. He desired the shareholders to understand that the item under cash at the bank, £924, must not be regarded as the whole of the capital they had at command. They had about £33,000 good debts owing from various customers; last year this item stood at £20,000, and the difference showed a remarkable improvement. The company's debts were also slightly larger than last year, but not more so than was fairly necessitated by the growing business. The chairman then devoted some time to assuring the shareholders that there was absolutely no cause, as far as the actual value of the shares of the company was concerned, for the fluctuations of those shares in the stock market; and he advised shareholders not to sell their shares below par. Another satisfactory thing was, that the public installations run by the company this year showed a substantial profit, against losses in previous years. The exact figures were not yet made out, but the profit was represented by three good figures. The South Eastern Railway Company had a Bill before Parliament for the extension of its line, and the plans were drawn to include a portion of the premises of this company, and, if carried out, would involve serious sacrifices and entitle them to substantial compensation. Petitions had been filed protesting against the action of the South Eastern Company, but if the plans of the latter were carried out he was glad they had waited until this company was in a dividend paying position, as they would receive a higher indemnity than if they paid no dividends. He trusted the negociations with the City Commissioners of Sewers for the lighting of the City were approaching a satisfactory termination, and if the work was entrusted to them they would have to find a large amount of capital to carry out the work. This would not prove difficult, but they were not rushing blindly into the matter, and had determined not to undertake it except upon a paying basis, and with the provisions that the contract should be for a number of years, that they should have the right to lay mains of sufficient size to supply customers on both sides, and that those mains should remain even if the contract with the City were interrupted. For the last eighteen months they had been doing a large business in Germany, but as the result of a visit of himself and Mr. Wynne to Berlin more extensive operations were to be undertaken there, whilst there was a prospect of large schemes of electric lighting in Dresden, Hamburg, and other places. With regard to the amendment of the Electric Lighting Act, they had received a large amount of assistance from numerous influential scientific gentlemen, and a Bill was to be brought before Parliament shortly by Lord Rayleigh. That Bill affected only the two clauses which left it to the option of the consumer to use what lamps he chose and provided for the compulsory purchase of an undertaking at the expiration of 21 years. If that Bill passed, as he felt assured it would, it would be one of the most useful and effectual relief works which could be supplied, and, seeing the tens of thousands of men

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who were now without employment, he trusted this fact would have some weight with the Government. The Chairman then alluded to the loss the board of the company had sustained through the retirement of Mr. Ladd and Mr. Courteney, two of the directors, but remarked that they had supplied their places with two gentlemen of eminent scientific, technical and administrative abilities in the persons of Lord Sudely and Major-General Webber. He concluded by moving the adoption of the report, and the declaration of a dividend of 2 per cent. per annum.

Mr. J. S. Sellon seconded the motion, and spoke hopefully of the future of the electrical industry, remarking that this corporation possessed the most comprehensive patents and those most nearly approaching perfection.

The motion was put to the meeting, and carried without discussion or dissent.

The retiring directors, Lord Thurlow, Mr. Sellon and Colonel Stewart, were re-elected, as also were the auditors, Messrs. Cooper Bros. and Co.

This concluded the business, and votes of thanks brought the meeting to a close.

The Phosphor-Bronze Company, Limited.

The report of the directors states that the net profits amount to £3,216 17s., after writing off the whole of the investment in Osborne & Company, Limited, amounting to £500, £482 12s. 7d. for depreciation of property, and £391 18s. 11d. for bad and doubtful debts. Out of this sum your directors recommend a dividend of 4 per cent. per annum, free of income tax, which will absorb £2,882 9s. 7d., and leave £334 7s. 5d. to be carried to the reserve fund, in liquidation of the debenture liability. The dividend of 4 per cent. will be paid on 27th February next, should the directors' recommendation be adopted. There has been a slight falling off in the sales of the past year as compared with those of 1884, which, considering the state of trade and the continually increasing competition, is not to be wondered at.

The investment of £2,000 in the Société Lazare Weiller and Company will produce a dividend of 5 per cent. per annum, and profit and loss account has therefore been credited with £100. This society intends placing a considerable sum to reserve, so that this investment will increase in value. The fact of Messrs. Lazare Weiller and Company having done a large trade in wire is also encouraging, as it proves the value of the new silicium-bronze telegraph and telephone wire, for which this company holds the patents for the United Kingdom, India, the British Colonies and Dependencies. The sales of wire, rods, tubes, sheet, and other articles produced by the mills, in Birmingham, have been larger in the past year than in 1884; but, unfortunately, owing to the great depression in trade, many of the company's Birmingham tenants have left without paying overdue rents, so that now, instead of obtaining £400 per annum for steam power, as formerly, only about £200 per annum are being paid. Over £163 for rents due in 1884, which were regarded as an asset in the last balance sheet, have been deducted from this year's accounts, owing to the utter inability of the tenants, through want of work, to pay anything. It must not be overlooked that the mills, by producing wire, rods, tubes, sheet, and other finished goods, enable the company to extend the area of its operations, and it requires but a very small extension in the trade of these articles to make the mills highly remunerative; but in order to meet the requirements of the day constant additions to the plant are necessary. The mills, and the old machinery therein, being kept in a good state of repair and preservation, and the expenses connected therewith being debited to revenue, your directors do not think it necessary to write off this year any sum for depreciation thereon.

In the cost of production of the company's goods at the foundry considerable economy has been effected; but as the advertising account has always been a very heavy and constantly increasing item of expenditure, your directors have determined to make a large reduction whilst trade is so depressed. This reduction will be apparent in the next year's accounts.

The torpedo boat is now completed, but the unfavourable weather has hitherto precluded any trial; meanwhile, negotiations are pending for her sale. The legal proceedings in connection with the building of this boat have ended satisfactorily, and at a comparatively trifling cost to the company. The French Government have, it appears, lately ordered two bronze torpedo boats, which circumstance appears to point to the ultimate adoption of bronze for the hulls of these vessels.

In order to secure a return to the company of some of the Liverpool business, and to execute local orders more promptly, your directors have, at a small cost, established a branch foundry there, which they anticipate will prove a profitable venture when the trade in that great shipping port begins to revive. This foundry practically pays its expenses already, and will be the means of securing local orders for castings, which would otherwise not be sent to the company's London foundry.

The company now make and sell gun metal, brass, and other alloys of a similar character, in the manufacture of which no extra expense is incurred, and as its travellers are enabled to take orders from consumers of metals who will not, or cannot, use the more expensive alloys of phosphor-bronze, it is hoped that the company will soon have a much larger volume of trade.

Since the circular issued on the 17th July, 1885, Vice-Admiral Sir J. Edmund Commerell, V.C., K.C.B., M.P., has joined the board, and Mr. J. W. Bushby has just resigned the chairmanship in his favour, but remains a director.

Telephone Company of Austria, Limited.

The adjourned second ordinary general meeting of this company was held at the offices, Walbrook, on Tuesday, under the presidency of Mr. Henry Grëwing.

The Chairman, in moving the adoption of the report, stated that at the date of the last meeting the accounts were not ready to be submitted. They had had to be rearranged in accordance with the requirements of the law of Austria; but after a good deal of correspondence they had been approved and passed by the London office. The results of the working had been very satisfactory, considering that they had had to deal with the worst period of the company's history. The increase both in the number of subscribers and in the revenue steadily continued, and they had every reason to believe that the next report would prove the correctness of their anticipations of future prosperity. He was glad to be able to state that very little damage had been done to their plant during the present winter months, and their exchange communications had been almost uninterrupted. To meet the requirements of Austrian law they had been obliged to alter the date of their financial year, which in future would run from the 31st of March. Their relation with the authorities in Austria, both Government and municipal, were most satisfactory, and he thought this augured well for the future of the company.

Mr. C. L. W. Fitzgerald seconded the motion, which was adopted.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.

The directors' report for the year ending December 31st, 1885, states that the net profit for the past year amounts to £65,862. Adding £40,070 13s. 3d. brought forward and £52,393 15s. premium on new shares issued, and deducting £20,779 interim dividend paid in July, there remains a disposable balance of £137,547 8s. 3d.

The directors have added to the reserve fund £55,000 (which includes the premium on the issue of new shares), and recommend the distribution of a dividend of £1 per share, free of income tax, amounting to £41,600, making, with the interim dividend, a total payment for the year of 15 per cent., and leaving £40,947 8s. 3d. to be carried forward.

In general sales and in cable work the amount of business done has been up to the average of the last few years.

Cables have been manufactured and laid connecting the Cape Verd Islands with the West Coast of Africa, and have been sold to the Eastern and Brazilian Submarine Telegraph Companies.

Coast cables connecting the Portuguese and French possessions in Western Africa are in course of manufacture, to be laid under a guarantee of traffic from Portugal and an annual subsidy from France. About 600 miles are already laid, and the whole line is to be completed during the present year, and worked by the West African Telegraph Company, Limited.

Besides other cable work, 530 miles were manufactured for the Government Indo-European Telegraph Department, and carried out to the Persian Gulf in, and laid from, the company's vessels. The company's share of the work has been handsomely acknowledged by Sir J. U. Bateman-Champain, K.C.M.G., Director-in-Chief, in his report to the India Office, recently published.

The death of Mr. George Henderson, which occurred towards the close of the year, is keenly felt by his colleagues. For more than 20 years he had, as director and chairman, given unwearied attention to the company's interests, often, in times less prosperous than the present, making himself personally liable on its behalf. His health had been failing for some time before his death; but almost to the last the Board had the benefit of his sober judgment and great experience.

The board have appointed Mr. Gray director in Mr. Henderson's place; and it is intended that he shall become managing director.

With a view to this, and to the further strengthening of the board, special resolutions will be submitted to an extraordinary general meeting of shareholders, to be held immediately after the ordinary general meeting.

The last of these special resolutions refers to the company's French works. The directors bear in mind the possibility that such a sale may be advantageously made sooner or later, and desire to have power to act if the opportunity should occur.

Telegraph Construction and Maintenance Company, Limited.—Subject to audit, the directors propose a dividend of 15 per cent. (£1 16s. per share), in addition to the interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1885.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 5th were £2,214, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for January, 1886, were £19,880; for the corresponding month of 1885, £20,800; and of 1884, £19,360.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended the 5th inst., were £2,814.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending January 31st were £3,200.

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NEW PATENTS—1886.

1458. "Electro-telegraphic apparatus." J. J. Ebel. Dated February 1.

1469. "Telegraphic printing apparatus." E. Edwards. (Communicated by L. A. E. Parment.) Dated February 1.

1470. "Recovering nickel from scraps of metal plated or coated therewith, chiefly designed for the manufacture of anodes for use in electroplating." H. H. Lake. (Communicated by La Société de Laminage du Nickel.) Dated February 1.

1493. "Dynamo-electric machines." H. J. Allison. (Communicated by W. L. Voelker.) Dated February 2. (*Complete.*)

1496. "Electric bells." T. P. C. Crampton. Dated February 2.

1538. "Materials or compositions for use for underground receptacles for electric wires or cables either alone or in conjunction with iron or steel." J. W. Butler. Dated February 2.

1539. "Electric cut-out or circuit breaker." F. F. Yeatman. Dated February 2.

1543. Electric candles." G. Ignatiev. Dated February 2.

1570. "Codes for telegraphing words or sentences." T. Workman. Dated February 3.

1586. "Flexible compression commutators and switches for electrical purposes." F. R. de Wolski. Dated February 3.

1591. "Telephonic switching apparatus." A. R. Bennett. Dated February 3.

1610. "Secondary or storage batteries." G. E. Dorman. Dated February 4.

1636. "Telephones." R. H. Ridout. Dated February 4.

1637. "Driving electric light machinery attached to axles of moving vehicles on railways and tramways." J. Radcliffe. Dated February 4.

1680. "Arrangements for permitting the use of telegraphic and telephonic apparatus upon the same line." H. H. Lake. (Communicated by La Société des Téléphones à Grande Distance.) Dated February 4.

1681. "Relay apparatus for telegraphic or other purposes." H. H. Lake. (Communicated by La Société des Téléphones à Grande Distance.) Dated February 4.

1684. "Secondary electric batteries." B. Weise. Dated February 4.

1726. "Incandescent electric lamps." L. S. Powell, R. P. Sellon. Dated February 5.

1747. "Electric sponge." G. Epstein. Dated February 5.

1754. "System of automatic telegraphic apparatus." A. M. Clark. (Communicated by Mde. Veuve Meyer.) Dated February 5.

1830. "Flying machine which flies off and either leaded by a man or by electricity." (*Sic.*) J. Walde. Dated February 8.

1860. "Voltaic belts." A. T. Sherwood. Dated February 9. (*Complete.*)

1877. "Electric lamps." N. Tesla. Dated February 9.

1887. "Electro-static gas lighter." C. A. Teske. Dated February 9.

1892. "Extracting metals from substances containing the same by electrolysis." L. Grabau. Dated February 9.

1899. "Art of telegraphy." G. A. Cardwell, W. P. Arnold. Dated February 9. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

1621. "Improvements in electric arc lamps." W. J. Mackenzie. Dated February 5. 8d. Relates to a development of the invention described in the specification of letters patent granted to the inventor and dated 7th January, 1882, No. 95. In the invention referred to, the inventor employs a small electromotor as the power for feeding together the carbons, but he arranges the motor to act in an improved manner, and he uses separate devices for striking the arc, for regulating the feed, and cutting the lamp out of circuit.

1855. "Improvements in apparatus for opening electric circuits to prevent damage, and also for stopping the motor driving a dynamo when its circuit is thus or otherwise opened." T. Nordenfelt. (Communicated from abroad by O. F. Jönsson, of Stockholm). Dated February 10. 8d. The current, in passing through this apparatus, divides and passes simultaneously through two electro-magnets, and, joining again, passes through three insulated rails. One of these rails is fixed, and the circuit between it and another movable rail is completed by each rail having on its end a piece descending into a vessel containing mercury. This vessel is mounted on the top of a vertical sliding bar. A spring tends to draw the bar down, but it rests on a piece connected with the armature of one of the magnets. This armature is held back by a spring sufficiently strong to overpower the attraction until the current has increased to such a degree that danger is imminent both to the dynamo machine and the circuits. The armature of the other electro-magnet consists of a double armed lever provided with metal screws in front of the poles of the electro-magnet, in order to diminish the effect of the residual magnetism. A hook is provided in order to retain the lever in its position when no current is passing through the apparatus. On the opposite end of the lever a weight is suspended, and from the weight a string passes over pulleys to a wheel, which is keyed on to the spindle of the stop valve of the motor in such a manner that the weight, when free in falling, closes the valve.

1857. "Apparatus for regulating the speed of a motor driving dynamo machines." T. Nordenfelt. (Communicated from abroad by O. F. Jonsson, of Stockholm.) Dated February 10. 8d. The apparatus consists of two parts, the first part is placed near the motor of the dynamo machine, it indicates by means of signals any change in the current, and further, by means of the second part, which is termed the regulator, increases or diminishes accordingly the amount of steam supplied to the motor.

1870. "Improvements relating to the use of electricity for the automatic stoppage of railway trains, and apparatus therefor." W. R. Lake. (Communicated from abroad by R. Snyers, of Brussels.) Dated February 10. 8d. Comprises a vertical shaft carrying at its upper part a horizontal plate. The said shaft is supported in a cast-iron frame having suitable bearings. A spring surrounds the shaft and has for its object to return the latter to its normal position when it has been moved from the same by a rotary motion. A ratchet-wheel keyed upon the vertical shaft has engaging with it a pawl having the form of a small bent lever, one arm of which carries the armature of an electro-magnet. The said ratchet-wheel and pawl serve to maintain the shaft in any desired position which is only altered under the action of the spring when the pawl attracted by the electro-magnet disengages from the ratchet-wheel. The said shaft carries a small cam designed to cause the oscillation of a vessel containing mercury and forming part of an electric circuit. The horizontal position of the bottle corresponds with the passage of the current. The bottle returns to its normal position by gravity, when it is no longer subjected to the action of the cam. The manner in which a train acts upon the apparatus and the apparatus reacts upon the train is as follows:—Each locomotive carries two brushes of very flexible and very elastic steel strips. The first brush placed in front of the engine has a thickness of from 5 to 10 centimetres and a width of from 25 to 30 centimetres. It can oscillate upon an axis; its oscillation being produced by the contact with an obstacle and causes the stoppage of the locomotive. The second brush is placed behind the first brush. It is several metres in length and from 25 to 30 centimetres in width. The said brushes are placed, one on the right-hand side, and the other on the left-hand side of the locomotive in such a manner that the first brush touches the plate only when it occupies a position at right angles to the rails, whilst the second brush encounters it when parallel to the rails, and has especially for its object to place it at right angles to the rails. For this purpose the strips of these brushes extend much lower down than the said plate, and in bending so as to pass above, they adhere and exert sufficient pressure to cause the first brush to oscillate, and to impart to the plate a rotary motion by the action of the second brush. Accordingly, when a train encounters the said apparatus, the plate being parallel to the rails, the first brush passes without hindrance. But the second brush coming immediately after places the plate at right angles to the rails in a position adapted to cause the stoppage of a train which may follow. At the same time that the rotation of the plate takes place, the small cam on the shaft causes the mercury vessel to oscillate and thus closes the circuit which is connected with the electro-magnet of the preceding apparatus. The pawl of this apparatus is then disengaged from its ratchet-wheel, and the plate is carried back to its normal position by the tension of the spring. It will thus be observed that the passage over one section of the line is allowed only when it is free, and when the train which occupied it has reached the following section.

2325. "Improvements in the construction of armatures for dynamo-electric machines." F. Wynne. Dated February 20. 11d. Relates to that class of armatures for dynamo-electric machines (generators and motors) known as disc or ring type, of which the well known "Brush" and "Schuckert" armatures are examples, and consists of a peculiar way of constructing the said armatures of a ribbon or band of iron.

2834. "Magnetic appliances designed to be worn chiefly for preventing sea sickness." W. L. Wise. (Communicated from abroad by G. Edard, of Paris.) Dated March 3. 8d. The appliances comprise a belt and a sole.

2924. "Automatic electric coupler." J. S. Raworth. Dated March 5. 8d. Consists of a magnet or electro-magnet, balanced on pivots and influenced by three solenoids; two of high resistance are shunts between the main leads and between the machine terminals respectively, and are arranged to have opposing influences upon the magnet, so that when the strengths of currents in the two solenoids are equal, the magnet will not move, but if the current due to the machine preponderates, the magnet will turn in one direction on its pivots and make the connection between the machine and the leads. As soon as this connection is made, the currents in the two shunt solenoids become equalised, and the magnet would lose its bias if it were not for the third solenoid,

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which is of low resistance, and carries either the whole or an adequate portion of the main current. The magnet is weighted on one side so that it will break connection with the main leads whenever the current ceases to flow through the solenoid of low resistance. If it should fail to act, and current should commence to come back through the machine, this reverse current will instantly move the magnet and break the connection.

2966. "An improved foot-step for telegraph posts, signal posts, and the like." A. E. GILBERT. Dated March 6. 6d. The improved foot-step is formed by stamping or cutting out of sheet iron or steel a bracket-shaped piece of approximately triangular form, with projecting parts on the vertical edge which are bent over on opposite sides to form holding lugs, through which spikes or bolts are passed to secure the footstep to the post, and with a sharp projecting claw at bottom, or top and bottom, to enter the post, and a projection at the end of the horizontal edge forming the tread or foot plate, to prevent slipping. For lightness the central part of the triangular bracket piece may be stamped or cut out.

3004. "Improvements in the construction of cables for conveying electric telegraph and telephone messages, and electricity for motive power and lighting purposes." J. C. SELLARS. Dated March 7. 8d. A cable according to the invention is constructed in the form of a flat band and consists of a number of wires placed side by side and running parallel to one another, the wires being covered by a material made damp-resisting and non-conducting.

3049. "Improvements in the construction and working of galvanic batteries." J. J. COLEMAN. Dated March 9. 8d. One form of the battery is constructed of pairs of elements of iron and copper immersed in cells containing a neutral saline solution of, say, common salt mixed with hyprochlorite of calcium (chloride of lime), or an alkaline solution of a hyprochlorite, by which means a powerful battery is easily formed without the use of porous cells. According to another modification the battery is constructed with pairs of iron and copper, the iron being immersed in a solution of a neutral salt, such as common salt, or of a proto-salt of iron and the copper in a solution of a salt of copper, such as a sulphate.

12897. "Improvements in switches for making and breaking electrical contacts." F. WYNNE. Dated October 27. 8d. Relates to that class of electrical switches, or contact apparatus, in which a spring toggle-joint is employed to retain a contact piece in either of its two extreme positions, and to provide that it is in unstable equilibrium or out of equilibrium in any intermediate position. The principal feature of the invention consists in obtaining this toggle-action by the alternate greater or less compression of a continuous helical spring placed across the line of motion of the contact piece, or pull or push piece, and fixed or secured at both ends.

CORRESPONDENCE.

Electric Alarms and Indicators.

In your issue of the 5th inst., under the heading of "New Patents," I see (No. 993) an electric alarm for hooks and pegs for hanging or suspending goods. Allow me respectfully to inform you that as far back as October, 1883, I made an arrangement for a bootmaker to hang his goods on outside his door, whereby should anything have been taken off the hooks or pegs the electric alarm would have given him notice of same. The working was so simple that I never had any intention of taking a patent out for my invention.

The way in which I made my arrangement was as follows: the hooks or pegs had a spring under them, which, when the weight was taken off, lifted the hook or peg, and so completed the circuit and gave the alarm. Should Mr. S. P. Weston have seen or heard of my arrangement, and it is worth copying, no doubt he will also think it worth recognising, if only by letter.

At the same time, allow me to state (at the beginning of last year), I made an improvement on the ordinary drop indicator, which caused the bell to continually ring until attention was drawn to same. This, Mr. Thurkle I find has fitted to indicators with his name on. I can only say, if the idea is worth using, it would not be out of place for him, or anyone, to thank a workman, like myself, who has it not in his power to patent his invention.

H. Albert.

Electric Light Department,
Army and Navy Hotel,
Westminster, *6th February*, 1886.

Telegraph Cables.

Can any one kindly inform me where I can procure a map of the world showing all the existing telegraph cables, and to what companies they belong?

E. O. W.

[We think our correspondent should apply for the map to Le Bureau International des Administrations Telegraphiques, of Berne, but it would probably be necessary to seek information from the cable companies also, respecting the lines they control.—EDS. ELEC. REV.]

Transmission of Power by Electricity in Mines.

Our attention has been called to some references in your columns to our experience here, underground, with electrical transmission of power, which now extends over several years. We will, before long, with your permission, put before your readers the results of this experience so far as practical working is concerned. We may say, so far it has been satisfactory and that we have been and are still extending its application.

Frank Brain, M.E., *Manager.*

Trafalgar Collieries,
Drybrook, Gloucestershire.

Electro-Magnetic Induction.

Professor Hughes has recently shown that the action of the current of a conductor upon a neighbouring conductor is the same as the action of the current flowing through a small portion of a conductor upon the remaining portions of that conductor.

The results of Prof. Hughes's experiments together with Lenz's well-known laws, suggest to me the following simple rules:

The electro-magnetic inertia of a conductor varies as $\frac{1}{\text{diameter}} = \frac{1}{D}$, so that the inertia of a unit length of a conductor carrying a constant current would vary as $\frac{1}{D}$. But if the current varied as the sectional area of the conductor, that is, if the current's density was kept constant, then the inertia of the conductor would vary as $\frac{D^2}{D} = D$.

The inertia of the conductor also varies as its length. Therefore the inertia of the conductor would be proportional to $L \times D \times$ current's density.

Since the volume of the conductor $\propto L\,D^2$, the inertia of the conductor would be proportional to $\frac{V}{D} \times$ current's density.

The coil of an electro-magnet should be treated as one conductor having a sectional area proportional to the sectional area of the coil; so that the inertia of electro-magnets is proportional to the square of their dimensions.

There would appear, however, to be an essential difference between the longitudinal and lateral inertia of a conductor; the former seems to control the induced E.M.F., the latter the *duration* of the extra current.

W. Moon.

February 8th, 1886.

Mechanical Telephone Patents.

It would be interesting to know what it is that constitutes a valid patent in the mechanical telephones now being offered to the public. The principle is as old as a Morse instrument. I believe wheel line-guides are claimed for one thing; if so, I can easily prove having used them many years ago.

Telegraph Engineer.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

Vol. XVIII.—No. 430.

DYNAMO-ELECTRIC MACHINERY.*

A few weeks ago in these columns we briefly surveyed the leading features of the new edition of Professor S. P. Thompson's book on "Dynamo-Electric Machinery"; but there are many points in this excellent treatise which call for more than a passing notice at our hands. In the second edition, a very successful attempt has been made to write dynamo machines up to date, and a large amount of new matter has been added in the form of new illustrations, extended letter press, and additional appendices. Apparently, no pains have been spared to secure the most reliable information respecting the subject in hand; the technical journals published here and on the Continent have been freely drawn upon, with the result that the book as it stands is crammed full of valuable information from beginning to end. The work now before us is the only one yet published which deals exclusively with dynamo-electric machinery, and, writing specially for students, we think the author is wise in supplementing his theory of the dynamo by a description of the practical methods actually employed in the experimental determinations required for constructing this class of apparatus. On reading through carefully Prof. Thompson's book, the reader does not fail to observe that some portions bear the mark of a later date, as if the author in the present edition viewed the dynamo from a somewhat different standpoint from that taken by him when the first edition was published. This is to be expected in dealing with a subject which has not yet reached complete development, but at the same time the impression remains on the mind of the reader that much of the matter which appeared in the former edition, might have been left out, or should have been modified in the present one, while much of the precious matter that appears in the appendices might have been advantageously incorporated into the text. That future editions of this valuable work will be called for is certain, but we trust in the next edition to see the book re-written from the beginning.

Professor Thompson's remarks on page 29, regarding "idle" wire on the interior surface of the Gramme core have an uncertain ring, and these remarks taken in conjunction with those on page 151, where the advantage in this respect from flat ring armatures is said to be *nil*, provided the total lines of force entering the core are not increased, might puzzle the student not a little. Again, on page 36, the author advises the use of long magnets for dynamos, while all constructors are agreed that the shorter the magnets are, the better is the machine, and they believe that the magnets ought to be made just of a length sufficient to provide the necessary surface for the radiation of heat from the magnetising coils. It must be remembered that the author gives his advice with a specific object in view; but if constructors consider the object attained by long magnets to be of no practical importance, and if the best practice proves that this is the case, then the paragraph referred to ought to be struck out in future editions. Paragraph x on page 37 ought to share the same fate. We are not aware that in any modern dynamo, iron or electro-magnets are placed inside the armature to reinforce the field, and in best forms of machine such devices are quite unnecessary. We would also question Prof. Thompson's opinions regarding the position of the coils on the field-magnet cores. To show the reason for his opinion that the wire should be wound most thickly at the centre of the magnet, the author refers us to fig. 6, p. 9; but a simple bar-magnet where the magnetic curves are mostly completed in air can scarcely be considered analogous to the field of a dynamo in which a large mass of iron nearly bridges over the two poles; and lately it has been proved by Mr. Kapp that the amount of magnetism is quite independent of the position of the coils on the magnet cores provided the ampère turns remain unaltered, a fact which had been hitherto tacitly assumed, if not clearly established.

In describing, on page 42, the different forms of field-magnets, we find the author condemning the practice of heaping on them a large quantity of wire. As a matter of fact, in series machines employed for arc lighting this is done with a purpose; and it is known that with less wire the machine will not work well. It is absolutely necessary for these dynamos to have a characteristic in which the electromotive force rises as the current diminishes, in order that lamps in series may work. A shunt dynamo fulfils the condition, but the cost of the wire and winding for the field-magnets in these machines of high potential is prohibitive. A series dynamo can, however, be made to fulfil the condition within the limits of variation of the working current if a large quantity of wire is piled on the magnets, the characteristic being then one in which the E.M.F. rises with great rapidity, attains a maximum, and falls through the range of working. It is necessary to bring the magnets to saturation before the machine is doing its maximum work. True the E.M.F. might be obtained for the particular working current by much less wire on the magnets, but the heaping up is essential to obtain the falling characteristic.

Coming, now, to the chapters on the various types of dynamos in practical use, we notice a somewhat hasty criticism respecting the most recent type of Siemens machine, for without any definition of what constitutes advancement in dynamo construction, the use of cast iron magnets is unhesitatingly characterised as a retrograde step. The enquiry as to what is really meant by improvement is an important one, and the question can only be decided, in our opinion, by re-

* "Dynamo-Electric Machinery," by Silvanus P. Thompson, D. Sc., B.A. (Second edition.) E. & F. N. Spon, London, 1886.

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ference to output, efficiency and first cost, the weight being a mere circumstance which may or may not be a disadvantage, depending upon the conditions under which the machine is to be employed. From many experiments the advantage of wrought over cast iron for magnets has been determined, the results showing that by the employment of the former a gain of from 10 to 25 per cent. is obtained. If two machines of similar dimensions are constructed with this difference, that in one the field magnets are of wrought, while in the other they are of cast iron, provided the armature core is sufficiently large in section to carry the increased field, the wrought iron magnet for the same excitement may yield 25 per cent. more lines of force. At the same time it must be remembered that the effect produced by a wrought iron magnet can be produced by one of cast iron if the cross section is made larger; and thus by a greater weight of iron and copper the same output at the same efficiency can be obtained. The question to be answered is, whether the cast iron or wrought iron machine is the less expensive, and upon this answer will depend that to the further question, whether the modification is an improvement or not. The change from wrought to cast iron may be a step in advance if the machine is less costly, and if advancement means a machine of similar capacity for less money. On the other hand, the modification may prove a retrograde step if the object sought to be attained is a machine of small weight. It is pretty certain that many types of machine can be made cheaper in cast than in wrought iron, especially in the smaller sizes, and we contend that it is impossible to say whether the dynamo ought to be made in wrought iron or in cast iron until it is decided whether cost or weight is the more important feature to be considered. We are told that it is possible to get cast iron on the Continent of very fine magnetic qualities, and it may not be generally known that there is less variation magnetically in samples of cast iron than in wrought. It seems to us that in many instances malleable castings might be employed with advantage for field-magnets.

We agree with Prof. Thompson in his condemnation of parallel groups of magnets, but we take exception to his adverse criticism respecting the pole-pieces of the Siemens machine. On page 161, he condemns the practice of making the pole-pieces thinner than the rest of the magnets, and in another place (page 498), when treating of magnets in which a hollowed space is cut out in the bars for the armature to rotate, he remarks that the shaping of the magnet core to this form must not be regarded as a mere thinning of the magnet, as such thinning would be disadvantageous. We cannot say that we clearly comprehend Prof. Thompson here. A pole-piece on such magnets is useless, and the bars can be thinned to a knife edge at the crown of the armature recess without interfering in the least with the efficiency of the machine or without increasing the resistance of the magnetic circuit, for the very simple reason that the lines of force approaching the armature from each magnet find their way into the armature core before arriving at the point named. It is worth while reminding our readers, *en passant*, that a pole-piece must be considered simply as a continuation of the magnets, its purpose being to give the necessary surface, and to prolong the full section of the magnet into proximity with the armature core. The necessity for a pole-piece is merely incidental to the structure of the machine. In most machines, where the axle runs parallel to the magnets, a pole-piece is absolutely necessary since the lines of force have to be redistributed in a new direction before they enter the armature, but where the axle lies at right angles to the magnet, as in the machine described, no pole-piece is required. As a matter of fact, the magnet in this instance is not thinned down at all, if by the term magnet we mean any section in the magnetic circuit through which lines of force pass, for these lines take the shortest way into the armature, and could not utilise the piece which has been cut out. The recess forms, therefore, a virtual pole-piece, no part of the magnet proper having been sacrificed in the thinning down. It is possible that this impression is identical with the one which Prof. Thompson seeks in his remarks to convey.

From the partially historical character of the book, it is probably necessary for the purpose of illustrating the evolution of the dynamo to publish the figs. on pp. 172, 206, and 207; but we think it would be well in future editions to keep those dynamos of the past, which have only a historical value, apart from those of modern type. As it is now, we find the Elphinstone-Vincent machine, an obsolete form, coming after the best modern designs, and a student reading the work through, had he no other guide, would feel uncertain as to which machine was the more important. Again, on page 213, we have the Lontin machine coming between the machines of Gordon and Ferranti, the former being obsolete, and the last two of modern build.

Passing on to Chapter XII., from whence Prof. Thompson develops his algebraic theory of the dynamo, we are met by a somewhat alarming array of symbols. In the formulæ given, as in most formulæ dealing with dynamos, there are too many coefficients, and it is not too much to say that a student with Thompson's book in hand would feel difficulty in designing a machine did he rely on that alone for information. We are tempted rather to regard a good deal of the theory set forth in the same light as that in which Prof. Thompson regards the mathematical labours of Clausius; and the question is, are these formulæ set forth for the purpose of enabling students to construct from their guidance a practical machine, or are they intended simply as a mathematical investigation of the action and reaction going on in a dynamo? If for the latter, then to the mathematician they are extremely interesting, and, from his particular point of view, qualitative symbols have no disadvantages; but if for the former, then we think they fail in the object sought, because the machine has to be constructed before the values of the coefficients can be determined. It is certainly instructive to determine in the laboratory the respective values of "H" and "A"; but the practical designer, degraded, doubtless, he will be thought, cares little what relation the strength of his field bears to the horizontal component of the earth's magnetic intensity. What he wishes to have before designing his machine is some reliable data respecting the number of convolutions and section of iron he must give to his armature. The qualitative formulæ of Thompson, with its armature coefficient and its geometrical coefficient, is useless to him; a quantitative formula is what he wants, and one from which he can obtain his requirements with the least possible trouble. Such a formula is given on page 134, where the E.M.F. of the machine is expressed directly in terms of the area of armature core, convolutions of conductor, and speed of rotation; and having determined from this formula the dimensions of the armature, it only remains for the designer to decide the size of field-magnets necessary for the saturation of the core. In this formula, the product $c.t.a.b$ takes the place of the "A" employed in that of Prof. Thompson; and it is to be remarked that with this substitution all the values are known, since "A" is practically a function of the cross section of armature core. The values of μ have been determined by experiment, and vary from 32 to 38, the exact figures which can be obtained for a given excitement depending on the quality of the iron in the field-magnets and armature, and on the resistance offered by the air spaces between the two. Prof. Thompson's formulæ give us no value of κ, and consequently does not help us to any solution regarding the strength of field produced by a given number of turns of wire on a given section of magnet core.

Recently, Mr. Kapp has given a formula which expresses quantitatively the strength of the field in terms of the exciting current and the resistance of the magnetic circuit; but we understand that the complete expressions which would necessitate the employment of a saturation term have not yet been published, the solution given being only applicable to very small values of exciting current. Whether it is possible to

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express by any formula of moderate dimensions the strength of field for all conditions of resistance when this saturation term is included, it is not for us to say, but there is no doubt that such a formula is very much wanted. As it is, the relation between the cross-section of the magnets and the cross-section of the armature varies greatly in different makes of machine, and we regret that no guide on this point is to be found in the work under review. The only part of the armature which should be approximately near saturation is the open part which lies between the horns or edges of the magnet; and although this part has on that account a higher magnetic resistance than the rest of the circuit, yet in armatures of small diameter it represents but a small fraction of the total resistance. Now a field-magnet of section equal to that of the armature core will give sufficient magnetism to saturate the latter; but this means either a very expensive way of producing the magnetism if the core is anywhere near saturation, or a larger armature than necessary if the magnets are not near saturation. This applies to incandescence machines; but for arc machines where the magnets should always be saturated, it would be correct to make the armature core equal in section to the magnets so as to take full advantage of this saturation. We are therefore working under sets of conditions quite different in these two cases, and the rules which apply to one cannot apply to the other. In incandescence machines compounded for constant potential, there ought to be a certain relation of the armature to the field-magnet section which is best, but that this has not been determined yet is obvious from the great differences found in practice. If the armature core is too small, then from its inability to take up additional lines of force save under strong excitement, the series wire will be excessive, while, on the other hand, if the core is made equal in cross-section to the magnets, the electrical resistance of the armature becomes increased along with its weight. The best practice in this class of dynamo consists in making the cross-section of the armature core from ·5 to ·7, that of the magnets.

In considering the relation of size to efficiency (page 271) we fail to follow the author's reasoning. He proposes to make a machine having n times the linear dimensions of an existing machine; it is to have the same number of convolutions on its field magnets and armature, the conductor being therefore n times the diameter of that of the existing machine and of area equal to n^2. Through this machine Prof. Thompson proposes a current of n^3 to flow, but the proposition is surely not a serious one. What becomes of the heat generated in the new machine? Is it realised that with a current of n^3 through $\frac{1}{n}$ resistance the heat generated in the machine is n^5, and that with this heat radiated from a surface of n^2 the rise in temperature will become n^3? There is no reason why the large dynamo should be worked at a higher temperature than the smaller one, and instead of the current being n^3 it ought to be less than n^2, really n if the temperature is to be the same in both machines. Since temperature is the limiting condition, this will materially modify the result given by Thompson; finally it will be found that the work given out by dynamos is about proportional to the weight if the speed is inversely as the linear dimensions, although the efficiency increases with the size.

Passing on to the chapters on self-regulating machines, a supplementary experimental determination for each combination is given, which will be of great value to the student. By the equations the windings are determined on the supposition that the saturation term may be neglected, and a reference is made on page 314 to Dr. Frölich's criticism of the method, the more complicated formulæ of the latter scientist being given in Appendix IV. We are far from suggesting that in future these complicated expressions should be introduced into the text, nevertheless we think it ought to be explained that the present equations give results which can scarcely be considered even as first approximations to the truth.

That the saturation term is really of very great importance may be seen from an example of the actual conditions present in this type of dynamo. In a machine compounded for constant potential, the E.M.F. required to send the current through the armature and series coil may be taken at 5 volts if 100 volts are required at the terminals. If the series wire furnishes half as many ampère turns excitement as the shunt wire we have

$$\frac{5}{100} \times \frac{2}{1} = \cdot 10$$

for the average value of each ampère turn of the series coil as compared with each ampère turn of the shunt, and if we take this example as that of a practical dynamo, the number of turns of series wire given by Thompson's formulæ will have to be multiplied by 10 to obtain the condition of constant potential. This is a rather important error coefficient, and these considerations will show the equations to be not of much use for self-regulating machines, as the solutions they give are not even approximate for dynamos as ordinarily constructed. We question whether it is worth while repeating in future editions the mathematical solutions for constant current, as the construction of machines on such principles involves conditions which are physically impossible.

Following that on compound winding is a chapter on alternating current dynamos, in which is given the latest information regarding this type, and this is followed by a valuable chapter on the coupling together of continuous and alternating current machines.

We recommend students to study most carefully Chap. XX., on the geometrical theory of the dynamo. Engineers are, as a rule, fond of graphic methods of representing facts, and with reason, since a diagram gives at a glance more information than several pages of formulæ, and the "characteristic" of his dynamo is, to the electrical engineer, what the indicator diagram is to the mechanical engineer; the lessons it conveys being fully as valuable.

Having already exceeded the ordinary limits of a review, we shall leave the subject of motors, which is an interesting one, for treatment on a future occasion. In the concluding sections of the work will be found chapters on "The dynamo as a motor," "The theory of electric motors," and "The government of motors," which are amply illustrated by examples of the best forms of apparatus, and which are well deserving of study. A chapter on "Testing dynamos and motors," concludes a work which we have read with pleasure, and of which we shall expect to see many future editions in future years. Written by an earnest student, for students it is in many respects a remarkable book, and in the opinions which we have ventured to express regarding points of difference, our object has been merely to create, in the partial darkness by which some of the solutions are obscured, a few rifts through which in the future a clearer light may shine.

ALTERNATING CURRENTS AND THEIR PART IN ELECTROTECHNICS.*

By MAX DERI.

(*Continued from page* 136.)

If we had a magnetic-field infinitely extended, and if the magnetic intensity would continually increase from a certain point to another very distant point, we could by moving the turn from the one point to the other point, generate currents in it which have in a certain space of time the same direction. But as this is in reality impracticable, and as motion in a limited magnetic field takes up only a short interval of time, it is clear that in a longer interval of time effects will be

* A paper read before the Elektrotechnische Verein, in Vienna, on the 18th of December, 1885.

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obtained in alternate directions, even whether we continue the motion by oscillation, reversing for that purpose its direction, or cause the fields to be repeatedly cut in the same direction.

We shall accordingly obtain nothing but alternating currents. Dynamo-electricity never produces in practice an absolutely continuous current as is generated by galvanic or thermo-electricity.

The currents generated by a dynamo machine, whether a continuous current or an alternating current machine, are then invariably alternating currents which we are, however, able to turn into the same direction. To that purpose serve the commutators or the extremely ingenious collectors introduced by Gramme.

If any one, without regard to construction and the distribution of material, were to assert that an alternating current machine must have less useful effect than a continuous current machine because the currents it produces are alternate, I should retort, That is an error. *Both machines generate alternating currents internally; the quality of the currents only differs in the external circuit of the machine.*

Is there, then, no difference between the two machines? Generally speaking, there is no difference. Any continuous current machine can at once be converted into an alternating current machine, if we only collect the currents as they are generated by the machine. For instance, a Gramme machine, or any other continuous current machine whose collectors are divided in many sectors, produces currents in the same direction if they are led away into the external circuit by means of two brushes which are tangents to the collector in the neutral magnetic zone. If we now join any two sectors diametrically opposite to one another, each to a metal ring and allow the brushes to slide over those rings, the machine will produce alternate currents. It is really a fact that the energy value of those alternating currents is exactly the same as that of the continuous current which was produced by turning the former into the same direction. The internal process remains the same, and that of changing the direction of the alternating current might rather cause a loss than an increase of useful effect.

The difference between machines thus arranged and proper alternating current machines is, that the number of their current or pole reversals is not the same. A Gramme continuous current machine has from 2,000—3,000, and an alternating current machine 6,000 or more reversals per minute. But as at present the continuous current machines are constructed—and that with good results—with two poles, their reversals take place with the same rapidity as in the case of the alternating current machines.

It is also further questioned whether the more rapid current reversals are detrimental to the useful effect of the machine? If the manner in which the machine is constructed should tend to favour the formation of "Foucault" currents, the more rapid reversal of poles would promote that tendency; but, on the other hand, the action of the induction is increased by the more rapid changes of the magnetic fields, the electromotive forces of the armature currents are higher, in consequence of which the internal resistance of the machine, which causes a great loss of energy, can be made lower than in the case of machines with slower reversals. This is borne out by experience.

There is indeed one difference between continuous current and alternating current machines which is decidedly in favour of the latter. The difference lies in the external circuit—the collection of the currents. The continuous current machine must be provided with a commutator or collector from which the currents are sent out, and that is its weak point. The alternate currents are sent into the circuit direct, as they are generated by the machine, either by means of contact rings which make a permanent contact, or—and better still—by means of fixed pole terminals direct from the armature.

It is true that with alternating current machines the objectionable process of turning the currents into one direction cannot be entirely avoided, for those machines require a continuous current for the purpose of exciting their field magnets. At all events the evil is in this case much less than in the case of continuous current machines, both machines yielding the same quantity of current. With a 100 H.P. continuous current machine 600—700 ampères must be turned into the same direction, whilst with a 100 H.P. alternating current machine perhaps only 20—30 ampères are required, the machine generating in both cases a current of an electromotive force of 100 volts.

Hence it is that one is not so restricted in the construction of alternating current machines as in the case of continuous current machines. An Edison 1,000-light machine is regarded as colossal, whilst an alternating current machine for 4,000—8,000 lights is nothing wonderful.

The cause of this is that, with an alternating current machine, the induced coils need not, as in the case of the continuous current machine, be connected to a collector by means of an extraordinary number of connecting wires; on the contrary, the armature coil wires can be easily distributed over the whole circumference of the whole structure in the most suitable manner. The coils can be so arranged as to remain stationary, in order not to expose them to the action of the centrifugal force, whilst the more massive parts of the machine can be caused to rotate instead. Such an arrangement has, down to the present time, been unsuccessfully attempted with continuous current machines.

It is owing to those properties that the alternating current machines require generally less revolutions than continuous current machines. Machines of the latter description making 500 revolutions per minute are rare, whilst for alternating current machines, producing the same effect, half the number of revolutions suffice. There are many such machines that run at 150 and even less revolutions per minute. No one will have a doubt as to the value of this property from a technical point of view.

The alternating current machines have another advantage over the continuous type, which, in my opinion, cannot be valued too highly; the difficulty of generating currents of a high electromotive force, for instance of several thousand volts, with a dynamo machine. Deprez has, with immense trouble, attained in a machine an electromotive force of 3,000—3,500 volts. It is still an open question what effect such a high electromotive force will have on the durability of Deprez's dynamos. I am decidedly of opinion that we shall sooner succeed in leading the thousands of volts safely and without loss through the long circuits than to confine them for any length of time in the armature coils of the dynamo.

In a continuous current armature, which must of necessity form the most compact part of the machine, it is altogether unavoidable that certain points of the current-conveying wires which have considerable differences of potential come in close proximity to one another. The coils themselves are mounted closely together, their connecting wires, and the sectors of the collectors, are still nearer to one another. The danger that, owing to flaws in the insulation, the high potential current "jumps across" is therefore very great.

Deprez has, then, acted judiciously in protecting the field-magnet coils from the high tension by exciting the magnetic fields separately.

Now, all those dangers are in properly constructed alternate current machines reduced to a minimum.

In such machines the armature may be arranged by separate coils in many parts; for instance, a machine with 20 magnetic fields must have at least 20 induced coils in its armature which are completely insulated from one another, and separated by a sensible space. Those coils are joined up in series, for which a single wire, which can easily be insulated and protected, is sufficient. When, for instance, the machine shall generate 6,000 volts, an electromotive force of 300 volts will fall to the share of each coil. It is, of course, very easy to protect the armature wire against the dangers from a tension of 300 volts. By thus distributing the

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electromotive force the difficulty can be indefinitely reduced. The field-magnet coils are in no way in connection with the currents of a high electromotive force, but they are circulated by independent currents of a low electromotive force.

To resume, then, I maintain that there is no reason why alternating current machines should not work with as much useful effect, and produce as much energy as continuous current machines. I have even pointed out properties of the former machines which give them great advantages over the latter.

I must remind you that I have been referring, not to the alternating currents, but to the alternating current machines. I will now proceed to consider the alternating currents with regard to their yield and useful effect.

Allow me to return to the subject of induction. I have shown that when a conductor is moved in a magnetic field electric currents are induced, and that those currents are always alternating currents. To this I will add, the induction will be more powerful if the moving conductor is armed with iron (the iron moving along with the conductor) in such a manner as to promote the circulation of the lines of force around it.

But induction currents can be generated without any movement of the bodies at all. I have already pointed out that no energy is expended in the formation of the lines of force, and that the only energy required in the generation of the current is that expended in moving the conductor. But as no current can be produced, without the expense of energy, real work must be expended in exciting the magnet in the case of induction without movement. But in this case the process is of another nature.

In order to illustrate this I will call your attention to the following phenomena, with which you are no doubt familiar. Suppose we have a continuous direct current generated by a constant electromotive force. We lead that current into an electro-motor. If we wish to prevent the armature from rotating, we have only to displace the sliding brushes, so that they are at right angles, to their normal position. The current is now led direct into the apparatus and passes the coils of the armature and of the electro-magnets, producing in them a closed circuit of lines of force.

The strength of the current in this circuit is represented, according to Ohm's law, by the quotient $\frac{\text{electromotive force}}{\text{resistances}}$. This is a magnetisation incapable of doing work, like that which I mentioned previously; the lines of force circulate now in the apparatus, in fact without action or useful effect.

But now I will show you a magnetisation which really consumes energy; which it is, however, able to give back by doing work. If we, without interrupting the circuit, restore the brushes to their normal position, the armature will at once begin to rotate; it will rotate the more rapidly as it experiences the less mechanical resistance. The resistance of the circuit has not been altered at all, and yet the strength of the current does not remain the same. We can see by the measuring apparatus that the current becomes the weaker the more the rapidity of the rotation increases; the rotation of the armature can even stop the current altogether. Such a system will not easily take up magnetic force. We must either oppose resistance to the rotation of the armature, or employ a higher electromotive force; in fact we must do both if we wish to maintain, with continued motion, the same current strength.

In this manner work is, indeed, expended in the formation of the lines of force, and the expense of work thus done is sometimes heavy; but in accordance with the law of the conservation of energy, this work is not lost but can be converted into mechanical energy, if we load the rotating armature with resistances: and this is the fundamental principle of the *electric transmission of power*.

The cause of the phenomenon to which I alluded, we call the *counter electromotive force*, or in this particular case, the counter electromotive force of the rotating armature.

Similar phenomena may occur with alternating currents without rotation or any other kind of motion.

The magnetic lines of force act in a different manner with rapidly changing currents than in the case of continuous currents. The energy of the currents lies in the changes. The lines of force which must change their direction and change their intensity from zero to maximum value a hundred times per second, or still more rapidly, produce in their atmosphere, curves, like those which are formed around the conductor which is being moved backward and forward in a magnetic field; consequently a current is induced in each linear conductor which comes under the influence of the changing lines of force.

The inductive action of the changing lines of force on a wire, a loop, a turn, or a spiral of wire, appears at first as a reaction. Whilst the continuous current always has the same intensity, represented according to Ohm's law by the quotient $\frac{\text{electromotive force}}{\text{resistances of circuit}}$, in the circuit formed by the wire, whether or not iron is present, the alternating currents will give quite different results. It appears that iron, which has been from time immemorial the symbol of rude, lawless violence, can also in this case set aside Ohm's law.

If we place iron—a bundle of iron wires for instance—inside the spirals through which, otherwise, unchangeable alternating currents circulate, the current strength in the circuit, whose resistance has, however, not altered, will sink the lower the more iron is introduced into the spirals. In this case, as in the case of the rotating armature, a counter electromotive force is set up; a peculiar property of the iron impedes the formation of alternating lines of force, and this counter force continues even whilst the iron from which it issues remains at rest; consequently, this counter force depends on the nature of the substance and not on a movement.

You will now see the importance of the changes of the current on the excitement of the magnetism. Whilst we are able to produce an infinite number of lines of force in a very large space by means of the smallest quantity of continuous current, we must expend, more or less, considerable energy, in order to produce magnetic lines of force by means of alternating currents. We only expend work in that mode of exciting magnetism when the energy of the lines of force is also consumed. Simultaneously with the counter electromotive force and parallel to it, a positive electromotive force is set up by the same cause of induction, when a second, a third, &c., linear conductor is brought within the sphere of action of the alternating lines of force.

Two conclusions may be deduced from this property of the alternating currents, namely: 1, that energetic inductive forces can be very easily produced and utilised everywhere by means of alernating currents; 2, that care must be taken that no useless work is done by the inherent energy of the alternating currents.

The counter electromotive force of a spiral through which alternating currents flow, and consequently, also, the electromotive force of a second spiral, depend evidently on the course of the alternations of the currents, and on the nature and the dimensions of the substances in which the lines of force are formed. Iron far exceeds all other substances in susceptibility of magnetic induction. The permeability of iron, that is, its property of conducting magnetic lines of force, is many hundred times greater than that of air. The more iron we use, and the more completely we fill with it the space in which the lines of forces are formed, the shorter they become and the more powerful in their action.

As we have seen that magnet poles can only be formed at those points where the lines of forces enter from the iron into the air, and as we have made the condition, that the lines of force shall not leave the iron at all, but shall circulate and vibrate in that metal, which offers the lowest resistance to them, we must make use of closed iron cores which have no magnet poles.

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In order to avoid losses, we must protect all metals that come under the influence of the lines of force, from those parasites which are known to us under the name of "Foucault" currents.

For induction, good conductors—metals—are required; namely, iron for the development of the magnetic lines of force, and copper for the development of the electric currents. The best plan is to use in both cases wires of small section. The iron wires must be mounted in the planes of equal magnetic intensity; that is, in planes which are perpendicular to the current, and the copper wires must be arranged parallel to the current. All wires must be insulated. A system thus arranged will be free from "Foucault" currents, for in it there are no dimensions in which those currents can be formed.

The best and most effective induction apparatus must then fulfil the following conditions: 1. It must allow the unimpeded and easy development of the lines of forces in circles which remain uninterruptedly in the iron; that is, it must have iron cores without poles which form closed magnetic fields; and, 2. The paths of the "Foucault" currents, which tend to develop themselves parallel to the primary current, must be cut off by insulation.

The following example will show the high degree of efficiency of the inductive action of an apparatus constructed in accordance with those principles:

One of our normal transformers* of 10 electrical H.P., or, to speak more correctly, of 7,200 watts effective, have the following resistances in the two spirals:

Primary spiral 1·15 ohms, secondary spiral 0·0045 ohm. In order to produce the above-mentioned normal yield the primary current is of 8·25 ampères, therefore the difference of potential necessary for a continuous current would be 8·25 × 1·15, or less than 10 volts. In reality, 918 volts are required for the purpose of overcoming the counter-electromotive force, when the alternations amount to 100 per second. It is still more striking when the secondary circuit is interrupted; in that case the strength of the primary current is 0·32 ampère. For the continuous current 0·32 × 1·15 = 0·37 volt were required, whilst the alternating current requires 900 volts, that is, 2,400-fold the tension of the former.

With the normal yield the primary spiral consumes 7,560 watts, whilst the secondary spiral gives 7,200 watts effective, which represents an efficiency of 95·2 per cent.

When running free, the primary spiral, in consequence of its self-induction, does not consume more than 210 watts, that is, 2·9 per cent. of the normal energy is required to excite the iron.

The internal resistance of the primary spiral amounts to 1·03 per cent, that of the secondary spiral to 0·9 per cent.; the total of the losses: 2·9 per cent. for the magnetisation, 1·9 per cent. for the internal resistances, is 4·8 per cent.

The apparatus contains 80 kilogrammes of iron and 33 kilogrammes of copper. In the former only 210 watts and in the latter only 140 watts are converted into heat, or scarcely $\frac{1}{6}$ heat units per second. Taking into consideration the radiation of heat, it will be seen that such an apparatus becomes very little heated. After having been in full action for several hours, the temperature of the transformer had increased about 25°, so that it might still be touched with the hand.

Where is the dynamo machine which can approach such an apparatus in effectiveness and value? Even the ideal dynamo machine must, when compared with a transformer, still have two disadvantages: 1. The loss due to friction caused by the rotation; and, 2. The dissipation of the lines of force into the air.

How important to the inductive action is the function of the iron will be evident from the fact that the above-mentioned transformer, without its iron core, would work with only 0·96 volt, the secondary current being interrupted, whilst with its iron core it would, under similar circumstances, show an action of 900 volts.

Anyone who is conversant with induction knows how resistances in which the self-induction is neutralised are constructed: the wire being insulated is doubled on itself and then wound in spirals or coiled. The current will flow through the spirals in such a manner that any two neighbouring current elements have always opposite directions. It is immaterial whether a continuous or an alternating current is sent through those spirals, for the real and the apparent resistances remain the same, even when masses of iron are introduced. Those wires are actually without self-induction.

You see, then, that two parallel circuits can exert different inductive actions. If their currents are in the same direction their external actions are added as if the two circuits formed one circuit of double the section. If the two currents are in opposite directions, their united actions only influence the space enclosed between them; externally their actions weaken one another, and that the more the farther the induction has to penetrate.

By this simple and reliable means we can avoid all loss due to induction in circuits. We place two circuits near and parallel to each other; between the two there is nothing but space, therefore no "Foucault" currents can be set up; metals which are situated outside the narrow sphere of action cannot cause losses because the resultant of the inductive action of both currents, even at a moderate distance, has no effect.

I must, however, point out that the inductive action, also without precautionary measures, is usually small, unless considerable masses of iron come accidentally into play, which fulfil the conditions I have previously laid down for an active induction.

By the action of induction the alternating current is greatly superior to the direct current. This action of the alternating current cannot be valued too highly, for it renders *transformation* possible. Is it not of the greatest importance that we are enabled to work with high electromotive forces for conquering distances, and that the high electromotive force, as soon as it becomes troublesome and unmanageable, is at once converted into a low and harmless electromotive force. How much more valuable would not Deprez's results be if he had been able to change his 6,000 volt current into a 100 volt current before leading it into the secondary machine! Can you imagine the possibility of a practical solution of the problem, when the electrical power which is supplied for domestic use, or for industrial purposes in the workshop, has an electromotive force of 6,000 volts?

The alternating current can be employed with equal success as the direct current for the purpose of producing light and heat.

In the case of the production of light—the arc light only—there is some difference in the action. The direct current has here the advantage that it hollows out a crater in the positive electrode which acts as a natural reflector and thus produces a greater illuminating effect; under the circumstances its energy has more useful effect. But, on the other hand, the alternating current has the advantage that both carbons consume at equal rates, hence it is that only that current can be used for Jablochkoff candles, Soleil lamps, &c. For incandescence light both kinds of current answer equally well.

Although the direct current only is at present used for the supply of motive power, it does not follow that the alternating currents are incapable of supplying that power; I even assert that the alternating currents can with useful effect be used for working electromotors, and can also in that respect favourably compete with the direct current. In this assertion I am not merely guided by my individual opinion, but it is also based on results of experiments which are not yet concluded.

Before concluding I must do justice, in one respect, to the direct currents. They possess one property which the alternating currents lack, that is, that the

* The Zipernowski-Déri-Blathy system.

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latter cannot do chemical work. Wherever polarity must act a part, the alternating currents are powerless. For electrolysis, that is for all metallurgic purposes, as well as for charging accumulators, they are useless. This particular field belongs exclusively to the direct currents.

But that is the only sphere of action from which the alternating currents are excluded; in all others they will successfully compete with the direct currents.

ON TELEPHONE SYSTEMS.*

By Prof. AMOS E. DOLBEAR.

(*Continued from page* 144.)

BELL'S SYSTEM.

Bell departed from the system already described. Beginning with the transmitter he dispensed with the movable electrodes and the variable resistance, and in the place of that apparatus he placed an electro-magnet with its armature, proposing to speak to the armature itself, which being set in, forced vibrations similar to the originating sound waves, which should react upon the poles of the magnet, and they upon the coils of wire surrounding them, and the current that was maintained in them by a galvanic battery, thus causing electrical waves in the circuit corresponding to the sound waves which produced them. The receiver was another

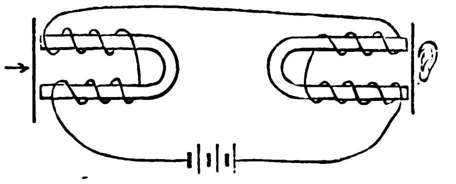

FIG. 5.

electro-magnet similar to the first, but so mounted that the vibrations set up there should reach the ear advantageously. So far as the action at the receiver was concerned, it was similar in all respects to the action in Reis's receiver, nevertheless the whole is deserving the distinction of a separate system, for the receiver now became a transmitter, and thus it had an entirely new function in addition to the old one. *The really new thing about it was the transmitter*, which acted by setting up electromotive forces in the circuit, which reacted upon the electromotive force of the battery, and therefore varied the strength of current in the circuit. The successive steps in this method are: sound vibrations in air causing forced vibrations in the armature of the magnet, varying the strength of the magnetic field. The varying field reacts upon the coil of the electro-magnet, and the current of electricity present in it, setting electromotive forces of a vibratory kind, now in this direction and now in that, according to whether the armature moved towards or away from the poles. The action is one of successive transformations of energy, the source of all the changing electromotive forces being the energy of the sound vibrations themselves, and therefore quite unlike the Reis transmitter, which is simply a controller of the electric energy which is provided by a separate source.

In the Reis transmitter, the strength of the current is varied by mechanical means directly, while in Bell's transmitter the current is varied by magnetic means directly. The contrast is still stronger, for on the one hand the changing currents are really vibratory, to and fro in direction, while in the other the currents are all in one direction, only varying in strength. The one produces its effects by *changing the direction* of its currents, the other by *varying* the strength of a continuous current.

* A Lecture delivered before the Franklin Institute, Friday, December 11th, 1885.

At the receiver, the succession of transformations is similar in each. The magnetic changes produced by the currents result in a varying magnetic field and a corresponding strength of attraction upon the armature, which moves in obedience and vibrates, imparting its energy to the adjacent air. As a matter of fact, the form of the electro-magnet employed for the transmitter was not the same as that used for a receiver. At the Centennial Exhibition of the telephone, the receiver was a cylindrical electro-magnet, the coil being within the cylinder, the armature being a disc that fitted like a cover upon one end of it. This receiver was given to Sir William Thomson, who carried it home with him. During transportation, the armature got bent up to an angle of forty or fifty degrees from its proper position facing the poles. Sir William testified in a London Court, where he showed the receiver with the armature still bent out of place, that he had endeavoured to make it talk after his return home, but had not succeeded, and he could not remember but that the armature was intended to be bent up as he found it on unpacking, so the man who made it was called up to testify what the intention was. I think that anyone less eminent than Sir William, who had been called as an expert, and who should give such testimony as that, would be at once ruled out as incompetent.

In the same year, 1876, I proposed to employ permanent magnets for both receiver and transmitter, so as to dispense with a battery, and have each instrument of the same form. This was before I knew anything as

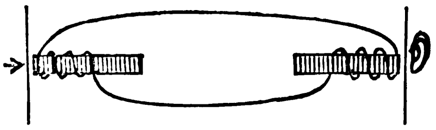

FIG. 6.

to the instruments that Bell had employed, and the first one made was with a straight bar magnet with the coil wound over only one end. This kind was soon found to be much more efficient than the electro-magnet and battery, and was adopted to the exclusion of the other. Considered as a system, however, it differs from Bell's only in this, that in the latter, the generated currents modified the current permanently in the circuit, while in mine the generated currents were the only ones in the circuit. Several electricians have stated that the two are identical, and that the only object of employing a battery was to keep the magnets magnetised, in spite of the well-enough known fact that a magnet may be made stronger by permanent magnetism than by a current on a line of any considerable external resistance, without using an inordinate battery. Somehow I had, for twenty years, the idea of the reciprocal action of magneto-electric devices. I had tried, in 1855, to make one magneto machine run another one, and, failing to do it, wrote to the editor of the *Scientific American* to know why it didn't work. The response was one of two or three lines in the column to correspondents, which answer I have forgotten, for I haven't seen the number since that time. It was marked "A. E. D., Mo.," where I was living at the time. Also, in 1864, I proposed a similar plan for a telegraph, the sender and receiver to be alike, and with similar functions. I mention these in justice to myself and in order to point out that there was nothing that was new to me in such combination of actions.

The system used at present in *legal telephony* consists

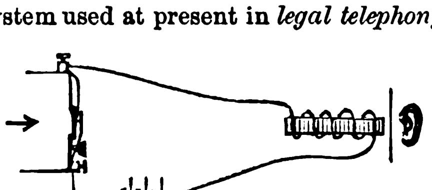

FIG. 7.

of a transmitter of the Reis pattern, and differing from it only in the substitution of hard carbon where Reis

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used platinum, while for a receiver is used my straight bar permanent magnet telephone of 1876. It is Reis's system plus a permanent magnet.

Berliner's System.

Berliner proposed a still more novel plan for a speaking telephone, because it involved principles unlike any of the others. His system consisted of a transmitter similar to the Reis's in principle, and his receiver

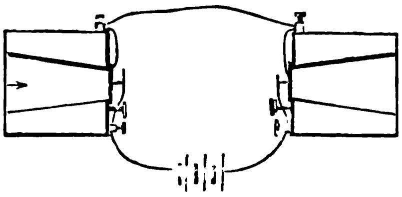

Fig. 8.

was a duplicate of the transmitter. The two similar instruments were to be put in circuit with a suitable battery, when an electric current would traverse the line. Talking to the transmitter would vary the strength of the current, and this varying current would vary the temperature of the electrodes at the receiving instrument enough to develop there what may be called a modified Trevelyan effect, and produce a sound, the character of which would depend upon the varying rate of the electrical energy spent at the terminals. The receiver could then be used as a transmitter, so that, like the Bell system, each instrument had a double function. The Berliner receiver depended upon the convertibility of electricity into heat, the latter at once doing work in moving the diaphragm. This was a highly ingenious plan, and is a system by itself, as much so as any I could name. The same principle has been varied somewhat and improved upon by others. I, myself, in 1878, used the heating effect of the current in a short wire to work a receiver.

Preece, in 1880 or 1881, likewise described some experiments of the same sort; while Cross has lately obtained surprisingly good results by using a platinum wire about six inches long, fixed to the middle of the diaphragm, and a current strong enough to keep the wire red hot. He described the effect to be such that the talking could be heard several inches from the receiver. In my opinion, the transformations of energy are the same in these cases, and I therefore include them under the head of Berliner's system.

Edison's System.

Ten or twelve years ago, Edison discovered that electricity was competent to lessen the friction between two surfaces, and, at first, adapted the discovery to a telegraphic receiver, and he gave the name Motograph to it. Later, he invented a telephonic transmitter, in which the current traversed a mass of lamp black, fastened between a solid back and a diaphragm, against which sound waves could impinge. The vibrations of

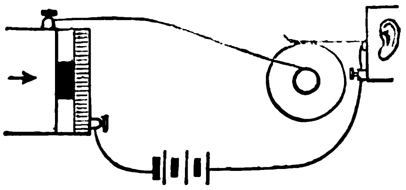

Fig. 9.

the diaphragm changed the conductivity of the parts and so varied the current. It is a variable resistance transmitter, in which lamp black takes the place of the platinum in Reis's transmitter. It was impossible, on account of the mechanical structure, that there could occur a break in the current in Edison's transmitter, and the changes in resistance were sufficiently great to make it excellent for its purpose. Edison then adapted his motograph to telephonic purposes, calling the modification a motophone, when he then possessed a telephonic system which, for loudness of performance, leaves nothing to be desired. It embodied mechanical details in the transmitter that vastly increased its efficiency, and in the receiver there were transformations electrical, chemical and mechanical, such as had not been even known until his discovery. I am very strongly of the opinion that Edison's system is one quite distinct from any other, being radically different from anything found in Reis, or Gray, or Bell.

Dolbear's System, No. 1.

In 1878 I devised what I called a battery transmitter, in which one of the battery plates was so mounted that the sound waves could impinge upon it and cause it to vibrate. In fact, the plate was used for the double function of a battery element and an acoustic diaphragm, the other element of the battery, zinc, being thick and rigid. The cell was thin and small, holding but about a tablespoonful of dilute acid. When this cell was spoken to, the vibrations of the plate were sufficient to give the proper characteristics to the current which the cell itself provided, and speech was rendered in the ordinary receiver with distinctness nearly "sufficient for every one." I also invented a

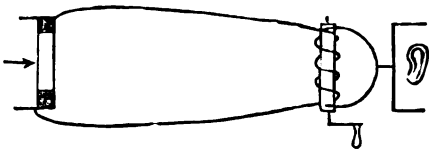

Fig. 10.

new receiver combining the attraction of a magnet, and the varying friction produced by the varying magnetism. An electro-magnet made with a core which could be rotated on its axis within its coil had resting upon its two poles the two ends of a curved armature, the middle point to which was fastened to the middle of a diaphragm. When a current of electricity traversed the coil, the magnet attracted the armature, holding it snug against the round sides. When now the core was rotated, the adhesion caused the middle of the plate to be bent in or out, as the turning was one way or the other. If the current varied in strength, the magnet varied in strength, the adhesion varied with it, and the armature was thrown into vibrations that corresponded with the current charges, and so speech could be rendered with it. In this it is the varying friction caused by magnetic changes which is the cause of the sounds, not magnetic induction as in Reis, or chemical dissociation as in Edison's, while the transmitter had the double function of both battery and transmitter, and, therefore, in accordance with my method of distinctions, I rightfully call this a system.

Dolbear's System, No. 2.

I once had a receiver so made as to permit a current of electricity to pass between two plates with a few drops of ammonium chloride between them in the expectation that the decomposition effected by the current would result in gaseous products which would move the plates. I found the result I expected, and had a receiver still different in principle from any I have described, in as much as the dissociative chemical relations of the electricity was the immediate cause of the sound vibrations. At one time, while experimenting with this the liquid leaked from between the plates, when I found I still heard the talking plainly. This new phenomenon I at once began to work out towards still better results until the receiver assumed

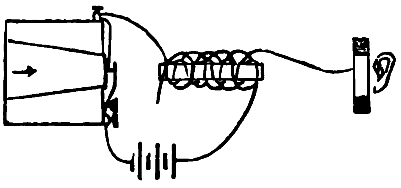

Fig. 11.

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its present form. For a transmitter, I found it necessary to use the high electromotive force which I could only get from an induction coil. Inasmuch as the receiver consisted of two plates as perfectly insulated from each other as it was possible to make them both by a thin layer of air and by thick varnishing, the resistance was practically infinite, and no current could traverse it; therefore a transmitter such as could only vary a current which must be maintained, was out of the question. An induction coil is an essential part of the apparatus. The complete transmitter consists of the variable resistant transmitter of the plan of Reis, hard carbon being used where Reis used platinum, combined with an induction coil of high resistance, 3,000 ohms or more, the terminals of this coil connected with the two plates of the receiver by the ordinary line wire. The structure of the receiver is such as to constitute it an air condenser, but in addition to that the varnishing upon the plates plays a very important part, an essential part in its commercial working, for it adds to the capacity of the condenser in two ways: (1) As an ordinary dielectric, and (2) in its absorptive property by which it becomes electrified, retaining its charge. It is then like a charged electroscope or electrometer, and is much more sensitive than when the plates are simply metallic and incapable of such electric action. In operation this system is radically different from the others, for (1) it is not operated by a current. The opposed plates are oppositely charged, and therefore attract each other. One of them is free to move slightly towards the other at its middle point, the strength of the attraction determining the amount of movement, but no current traverses the receiver for its resistance is measured by thousands of megohms and Ohm's law has no application to it. (2) The electrical condition of the line is entirely different from that in the other lines, for as no electricity can flow through it, the line itself becomes a charged body, and any electrical changes taking place in it are of the nature of electrostatic phenomena. In the magneto telephone the electricity goes uninterruptedly through the coil to the ground beyond. In the static telephone it comes to an impassable barrier and it accumulates there, it piles up, so to speak, as the tide does against the shore. The line, therefore, may have its electrical condition likened to an ocean tide and a continuous change of level, while the magneto line may be likened to an unobstructed river with variable quantities of water flowing. Prof. Cross who has made measurements of the current strength employed in telephones with various transmitters, reports that there was no measurable current in my line, which is just what I have maintained from the outset must be the case. But there have been some electricians who have declared that so far as the line was concerned there were currents in it just the same as in the common telephone lines. (3) High electromotive force is another essential condition. A battery and a transmitter, however good for magneto purposes, will not work my receiver, for it is the function of the transmitter to vary the current, and if there be no current evidently there can be nothing to vary.

As both transmitter and receiver are necessarily unlike any of the others, and as the transferring line is in a different electrical condition, and the character of the transformations of energy not to be found in the others, it is a system by itself.

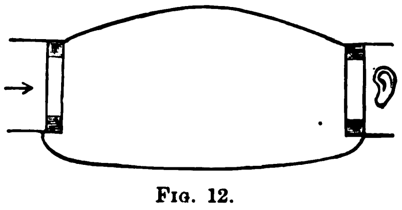

FIG. 12.

If two receivers be placed in same circuit uncharged if one attempts to use the arrangement for the transmission of speech he will fail, for merely vibrating one plate near another will not generate an electrical phenomenon, but if the line be charged in any way, one may then use each instrument as transmitter or receiver. In this way I have worked successfully over a half mile of line with the most ordinary insulation.

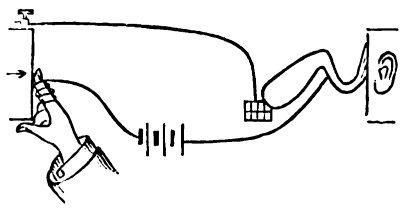

FIG. 13.

(4) In 1878 I found that if an electric circuit was completed through the finger in contact with the bottom of a tin cup, the current on the line would be varied by the change in pressure produced by sound vibrations in the cup, so that it was a variable resistance transmitter. With a dozen gravity cells and the end of the finger moistened it is a tolerably efficient transmitter. The receiver with which I have represented this transmitter in circuit is an ideal receiver which I have threatened to make every summer for six or eight years, but have never done it. Ever since Galvani's experiment with the frog's leg that has been a standard experiment, yet I confess I never witnessed the phenomenon. It is said that the properly prepared leg of a frog is a particularly delicate electroscope, and that it only requires the contact of a piece of zinc and copper to throw the leg into spasms. I therefore proposed to connect such a leg with the plate of a telephone, completing the circuit through the leg, a battery and a transmitter, expecting that the changing currents would cause corresponding muscular movements of the frog's leg which would be communicated to the plate, in which case the diagram represents still another system.

BREGUET SYSTEM.

There is but one other complete system that I chance to know of, and that is Breguet's. Lippmann made the discovery that the surface of mercury was visibly deformed by a current of electricity upon it from the point, and Breguet reduced this to telephonic purposes. Transmitter and receiver are both alike and have

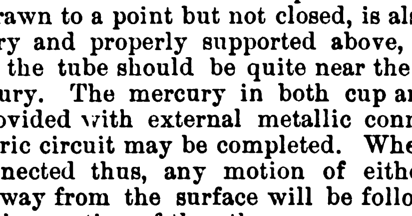

FIG. 14.

similar functions. A glass vessel contains some mercury with some acidulated water upon it. A small glass tube drawn to a point but not closed, is also filled with mercury and properly supported above, so that the point of the tube should be quite near the surface of the mercury. The mercury in both cup and tube must be provided with external metallic connections that an electric circuit may be completed. When these two are connected thus, any motion of either tube towards or away from the surface will be followed by a corresponding motion of the other.

There are several telephone inventions of importance, and some of them of the highest, that are in the nature of improvements. Transmitters and receivers have both been made more efficient by their use, while some have only a scientific and theoretical interest. A few of these I shall notice.

Among transmitters embodying difference in principle I would name the thermo-electric pile. In 1873 I described at the Portland meeting of the American Association for the Advancement of Science, an experiment I had made "On the Convertability of Sound into Electricity," in which the vibration of a tuning

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fork upon the face of a thermopile had developed electricity. At the time the criticism on the paper was that the vibration resulted in heat, which was the cause of the phenomenon.

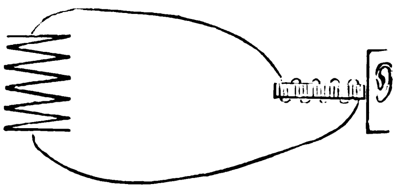

Fig. 15.

As soon as the magneto telephone was available for the test I coupled it in circuit with a thermopile and applied the tuning fork as before, and at once heard the pitch of the fork at the receiver, and that, too, at the distance of half-a-mile from the thermopile. I have also heard the voice, but only very weakly, with a thermo transmitter. The electromotive forces are at best but about ·0001 of a volt, and with such nothing much can be expected. As contrasted with such weak currents an electric arc, half-an-inch long, is at the other extreme.

As the arc is exceedingly sensitive to air currents, and as an arc may be blown out with the breath, it occurred to me that possibly the changes in density in air vibrations made to go through an arc would vary the current strength enough to enable sounds to be

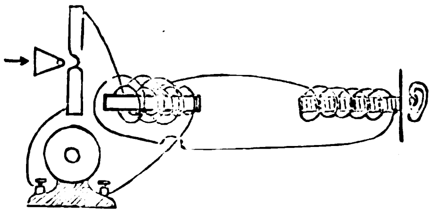

Fig. 16.

reproduced by it. The sounds were directed to the arc by a speaking tube, every word spoken driving the sparks two or three inches away from the arc. The current was passed through the primary wire of a large induction coil that could not be injured by such a current of 15 or 20 ampères. The terminals of the secondary connected alternately with the magneto and the static receivers. Only the faintest show of a sound could be heard. I did, however, hear some sounds, but not speech. Whistling was plainest.

I discovered one thing of interest and of some importance, too, as bearing upon future improvements in transmitters ; that is, that the most sudden break of such a current produced an hundred times less sonorous effect in the receiving telephone than the break from a single Leclanché cell would give. The explanation probable is, that it is impossible to produce a sudden enough break to affect the telephone, so that the ear could perceive it. Not that the ordinary effect of magnetisation and demagnetisation are not perceived, but their gradualness prevents an acoustic effect. It was not possible to get a spark of any appreciable length by the breaking of such a current, though with half-a-dozen bichromate cells a spark four or five inches long was easily obtained. As it has been found by experience that an electromotive force greater than three or four volts in the primary circuit with a Blake or other transmitter of that kind was not so efficient as less, I take it to be explained that within the slight movable distances to which the the terminals of such transmitters are subject, the formation of an arc across the space is detrimental to the performance, for if there be an arc the current is not varied, it continues right on with no considerable diminution. It is, therefore, necessary to use a lower electromotive force, and that from two Leclanché cells, say three volts, is as much as can ever be employed with such transmitters.

Elisha Gray discovered a curious electro-physiological phenomenon a good many years ago, that when vibratory high tension currents passed through a finger contact upon a movable metallic surface that there was an apparent increased adhesion, and the metal gave out a sound which was the pitch of the interruption of the circuit. This he modified into a telephonic receiver. The phenomenon is curious when compared with that of the motophone of Edison, for in the latter the friction is lessened by the current, while in the former it is increased.

Lastly, there are three telephonic receivers, which have nothing but novelty to recommend them, but I thought you might like to know of them.

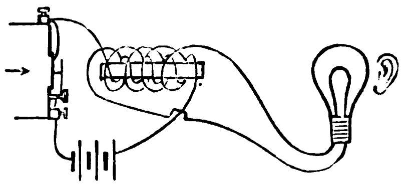

Fig. 17.

(1.) An incandescent electric lamp of the ordinary sort makes a speech receiver. The current needs to be a strong one, and it performs better when the current is sufficient to heat the filament to low redness. I suppose it is to be explained by what I have described under the head of Berliner's system.

(2.) Crooke's tubes may be similarly employed, only a high resistance induction coil is needed. By using one in which the gaseous impacts are against the side of the tube, or bulb, and that held against the ear, one may hear the spoken words.

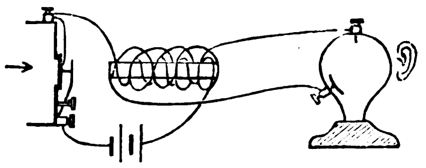

Fig. 18.

3. A Leyden jar of the ordinary pattern held, one hand grasping the outer coating while the knob is placed in the ear, the two coatings being the terminals of a secondary from almost any kind of a transmitter.

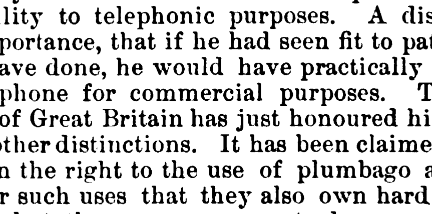

Fig. 19.

It was Hughes, of England, who discovered the great sensitivity of hard carbon and pointed out its adaptability to telephonic purposes. A discovery of such importance, that if he had seen fit to patent, as he might have done, he would have practically controlled the telephone for commercial purposes. The Royal Society of Great Britain has just honoured him for this among other distinctions. It has been claimed by those who own the right to the use of plumbago and lampblack for such uses that they also own hard carbon of any sort, but they are no more to be compared than peat and anthracite.

The properties of a body are not the properties of the atoms of the body, but depend upon the molecular constitution and arrangement of the body. It is the atom that is named carbon. It is the molecular properties that are wanted, and the molecular properties are not the same in lampblack and gas coke. If one should discover that starch could be used for a certain useful purpose, and afterwards some one should discover that cotton would answer very much better, and if the first should then claim the cotton because he first described an amylose for the purpose, the cases would be similar. Yet I heard Sir William Thomson say that it required but an infinitesimal amount of invention to substitute

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gas coke for lampblack, and we all know what infinitesimal means to him.

The Blake transmitter consists simply in the adoption of Hughes's hard carbon for the platinum in Reis's transmitter. It makes it much more efficient, but does not change its mode of operation nor vary the mechanical relations.

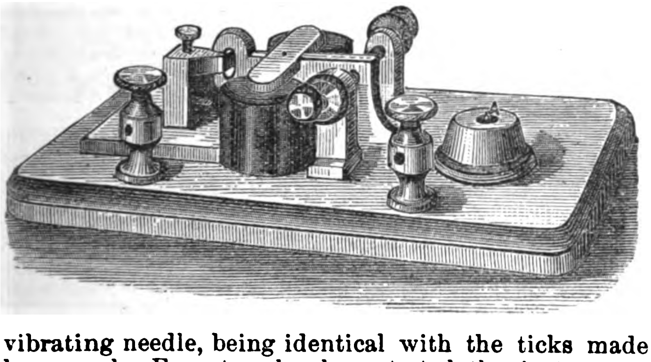
Hunnings, an English clergyman, has made a very useful transmitter by employing granulated hard carbon, arranged mechanically in the circuit as Edison arranged his carbon button, and with this transmitter the best long line work has been done.

In conclusion, I do not pretend to say who was the first inventor of an art of telephony, but I think I have made it plain that there are several arts of telephony that are complete in themselves, just as there are several arts of picture painting. One man paints with a brush, another with a roller and a press. When the pictures are done, no one can tell, by inspection, which way either was made, hence it is improper to speak of *the* art of picture making. Leaving out all that was done before 1876, I submit that the work of that year ought not to control systems that have been invented and discovered in their entirety since that time, and have almost nothing in common with it. I protest against it in the name of law which has been misjudged; I protest against it in the name of equity which has been scandalised; and I protest against it in the name of science, whose eyes are not bandaged as are the eyes of justice, herself a judge, the court of highest appeal, and who writes after every signature to a judgment in her court, *competent* or *incompetent*.

THE SENSOPHONE OR TOUCH-SOUNDER.

THIS instrument, which is patented in the United States and foreign countries, is claimed to be the only one ever perfected by which a telegram can be received by the sense of touch, the patents being owned by the United States Electrical Company, of New York.

By placing the finger upon the touch point, A, according to the description given by our namesake in America, this receiver will deliver the message to the operator by a series of light pricks, caused by a



vibrating needle, being identical with the ticks made by sound. Experts who have tested the instrument affirm that they can receive faster and with greater accuracy than by sound. For those who have learned to read by sound, this instrument offers no obstacle. By removing the finger, the instrument resumes its functions as a sounder; thus the utilisation of two senses are combined. The opening of a new sense in the art of telegraphy offers a field of usefulness to deaf mutes, whose sense of touch is particularly sensitive.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

IX.

WE have seen that the maximum current used with one car running upon the tramline (fig. 8, *ante*) was 47·1 ampères; and the average working current during the whole journey amounted to 14·68 ampères. No allowance has been made for the extra effort required in starting the vehicle from rest; in fact, the figures were based on the assumption that the vehicles were kept in continuous motion. We know that this initial current depends upon the resistance of the motor, and if this resistance is, say, 1·6 ohms, then (avoiding artificial resistances) the current flowing at the instant of starting one car will be $\frac{200}{1{\cdot}6 + {\cdot}4} = 100$ amperes. Four cars starting simultaneously would, without inserting artificial resistances, take $\frac{200}{{\cdot}4 + {\cdot}4} = 250$ ampères; and it is doubtful whether four vehicles could start with less than 62·5 ampères each on the more difficult parts of the line before us. The resistance of the generating dynamo is, for economic reasons, very small; consequently, this factor, if introduced, will but little affect the results. It is evident that this dynamo may have to furnish currents varying between 178 and 350 ampères, or even more, and the average energy arrived at in our previous calculations will have to be considerably modified, whilst the maximum power of the steam engine and dynamo must be at least double what may appear to be sufficient to maintain the traffic of 12 cars. The average energy utilised will not be double if the stopping and starting occurs at long intervals, and this will entirely depend on local circumstances; but we believe that for the case under consideration an engine, capable of giving out at any moment and at frequent intervals, a power of at least 150 H.P. may be required, not indicated, but actual brake H.P. when allowing a commercial efficiency of 85 per cent. for the dynamo machine.

If each car stops only twice every mile, then we get a total of 144 stoppages her hour; but this will be considered a very low estimate when compared with the statistics of town traffic, where on an average *seven* passengers are taken up and set down per mile run by each car. At this rate our 12 cars would have 508 stoppages each hour, or one every 7 seconds. This explains the discrepancy between the theoretical or calculated and the actual power employed on electric railways; up to the present day there is no electrically-worked tramway or railway in existence which can boast of more than four cars in continuous use.

The idea of using conductors for electric tramways appears very simple and effective so long as one car only is being propelled, but each additional vehicle brings its difficulties, and the time seems far distant for one to imagine an ordinary street tramway having, say, 30 cars or more in constant use, worked electrically in the manner described above.

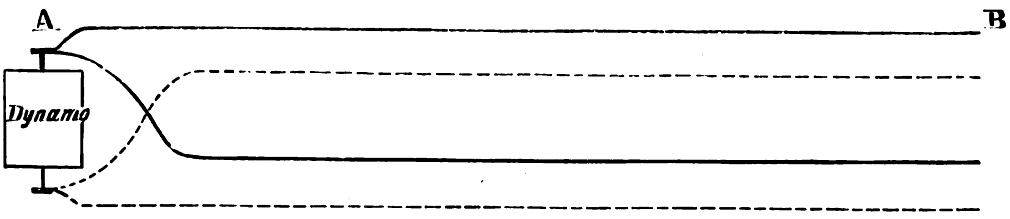


FIG. 10.

The circuit (fig. 9) was chosen with the view of simplifying the problem, but the circuit (fig. 10) will be preferred on the grounds of economy, because with the same quantity of material we get one quarter of the resistance and apparently less waste of energy caused by heating the conductors. But here we have

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a varying resistance as the car proceeds on its journey from A to B, therefore a varying E.M.F., and with it a reduction in speed as the vehicle approaches the terminus furthest from the dynamo. In this case we have either to make the sacrifice of introducing artificial resistances when the motor gets near the generating station, or we have to allow the car to run slower and slower as it travels outwards. There, again, the fault is not very serious with one car on the line, but it offers real difficulties with a number of motors running simultaneously.

The effect of a variable conductor resistance can be easily calculated for any point, but it is interesting to plot curves or diagrams and thus show the variations graphically. Dr. Frölich, in the year 1883, gave a method represented in fig. 11.

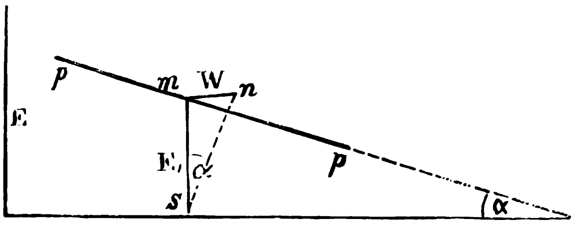

FIG. 11.

The resistances are drawn as abcissæ, and the E.M.Fs. as ordinates; the current is then at that point where no E.M.F. exists equal to the tangent of the angle, *a*. The fall of E.M.F. corresponding to the increasing resistance is represented by the line, *p*, *p*, and the electrical work, W, can be graphically represented from any point, *m*.

Thus C = tan. *a*,
E_1 = the E.M.F. at any point, *m*,
W = E_1 C = E_1 tan. *a*.

By drawing from *m* the line, E_1, at right angles to R, and from the intersecting point, *s*, a line, *s*, *n*, at right angles to *p*, *p*, we obtain *m*, *n* as the tangent, giving the work available at *m*.

The speed of a car on a perfectly level line will be proportional to the distance of the same from the imaginary point where lines *p*, *p* and R meet.

If there are gradients, then we have to plot the parallel components of the gravitation effects.

The requisite H.P. of the motor being known for all the gradients, the corresponding currents are easily ascertained. These currents give us the inclination of the E.M.F. line, *p*, *p*, in diagram, fig. 11; we are thus enabled to draw the E.M.F. line for any part of the road and construct upon it the corresponding work absorbed; in dividing the work by the tractive force we get the speed. In this way we may draw a chart which will show at a glance the energy expended as well as the speed at any desired point on the tramline.

In figs. 9 and 10 the generating stations were placed at one end of the line, but whenever convenient it is advantageous to place the dynamo half way, and thereby reduce the conductor resistance once more, *vide* fig. 12.

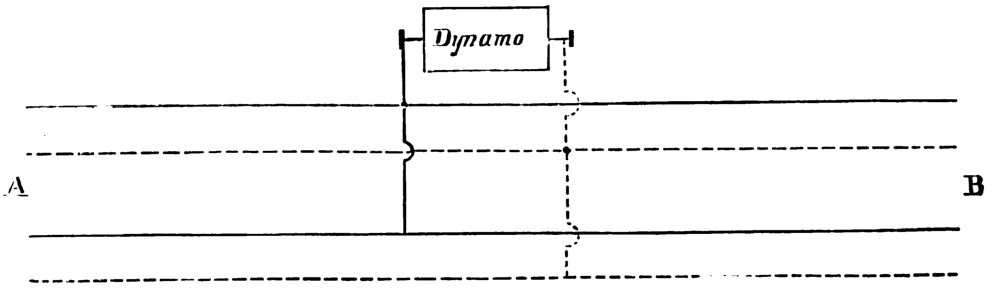

FIG. 12.

Telepraphic Revenue.—The receipts on the telegraphic service from April 1st, 1885, to February 13th, 1886, amounted to £1,535,000, against £1,550,000 received from April 1st, 1884, to February 14th, 1885.

LEGAL.

The "Otto" Engine in Germany.—The judgment in the case of Körting Brothers, of Hanover and London *versus* The Deutz Gas-Engine Works, was published in Leipzig on the 30th of January last, and is certain to have the greatest influence on the development of the German gas-engine industry.

The Deutz Gas-Engine Works were the owners of three patents (Dr. Otto's), which gave them the entire monopoly of the gas-engine trade in Germany. By their interpretation of the first claim in Patent No. 532, they asserted that they alone had the right to use an explosive charge consisting of a heterogeneous mixture of gas, atmospheric air, and indifferent gases or products of combustion, so that every gas motor which employed such a charge was considered by them to be an infringement of their patent rights, and builders of such engines were accordingly proceeded against. This claim was especially brought to bear against all engines using a heterogeneous mixture, in which the charge was ignited at that point where there was most gas, namely—at the port where the charge was admitted to the cylinder.

The second and third claims of Patent No. 532, extended the general principle described in the first claim to engines which worked without compression as well as those which compressed the charge previous to ignition. The fourth claim gave the Deutzer Gas-Engine Works the sole right to make engines worked on the so-called "viertact" or four-cycle principle, in which the same cylinder is employed as the pump and as the working cylinder.

If the first, second, and third claims gave them the sole right to employ a rational theoretical principle in the making of gas-engines, the fourth claim gave them the monopoly of the only rational mechanical method on which gas-engines can be built, and it is, therefore, not to be wondered at that these four claims were always considered by the Deutz Gas-Engine Works to be the most valuable part of their patent. In addition to these, there is, in Patent No. 532 (English 1876 Patent), a fifth claim, which is merely expressed by the words "the construction as described." This claim, which is found in many patents, was intended in this case, as it is in all others, to give the patentee a protective right against infringement of the general arrangement and construction of his invention as described in his specification, and signifies the erection or putting together of the separate parts so as to form a complete machine; therefore, any single detail, as such, is not protected by this claim. This has already been decided in former actions in which the Deutz Gas-Engine Works have been engaged.

It is to be noticed with regard to Patent No. 2,735 (English patent of 1877), that this only refers to the constructive arrangements, the special feature being claim two, concerning the slide, which is used in the present engines built at the Deutzer Works, and the novelty of which remains unquestioned by Messrs. Körting. In the first claim of this patent there is specified the arrangement of a port axial to the cylinder, through which the ignition flame is intended to pass, and by entering rapidly or, as it were, shooting into the midst of the explosive gases in the cylinder, to bring the whole charge at once to the point of ignition, and so produce an instantaneous explosion. This method of igniting the charge is, according to the specification, only intended to allow of the ignition of a homogeneous mixture in contradistinction to Patent No. 532 (1876), in which the mixture is to be ignited at that part which contains most gas. This claim, therefore, only refers to a detail in the construction to provide means whereby a homogeneous mixture may be ignited.

Further, the Deutz Gas-Engine Works possessed by their specification No. 14,254, a patent for the "special construction of a gas-engine with compression pump, and the method of work-

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ing such an engine." So far as we know, the Deutzer firm have never made an engine according to this specification, probably for the reason that engines working with a compression pump cannot successfully compete with those which have only one cylinder.

In the recently concluded case Messrs. Körting had attacked the whole of Patent No. 532 (1876), and the first claim of Patent No. 2,735 (1877), the latter on account of the Deutz Gas-Engine Works having attempted to give a general interpretation to this claim also.

Besides Messrs. Körting, the firm of Buss, Sombart and Co., Magdeburgh, had also attacked Patent No. 532 and Patent 14,254.

By the decision now published of the "Reichsgericht" (the highest Court of Justice in Germany), the claims one, two, three and four of Patent No. 532, have been definitely invalidated and done away with. Of this patent there, therefore, only remains the fifth claim, which refers to the arrangement of the whole engine, as such, but which does not secure a Patent for any separate detail or method of construction. This claim has in any case no practical signification whatever, as, up to the present time, no engine has been constructed according to this specification.

The first claim of Patent No. 2,735 has also been allowed to remain, and also, of course, the second claim, the validity of which was not questioned. The Deutz firm, therefore, still retain their patent for the slide, and also for the long ignition port intended to produce an instantaneous combustion of the charge; and, further, the special constructive arrangement of the engine described in Patent No. 14,254, which, however, is of no great importance, as it would never occur to any one to make such an engine. On the other hand, the important principles of the Deutzer Patent, which for a long time have prevented free competition in the gas-engine trade in Germany, have now fallen to the ground.

The "Reichsgericht" has decided, that the four-cycle movement mentioned in the fourth claim of Patent No. 532, is not an invention of Dr. Otto; but, on the ground of being known to former inventors, shall be for the "common good of all." Therefore, every engineer is now free to build an engine on the four-cycle principle if he so wishes. Furthermore, the claims 1, 2 and 3 of this patent embodying the principle of the formation of the charge for engines with and without compression have been annulled, and in this case also it has been decided that this principle is no invention of Dr. Otto; but, in consequence of its having been known to older inventors, shall be public property, for the "common good of all." Every engineer is therefore at liberty to employ a heterogeneous mixture for the charge, and to leave a space at the end of the cylinder to contain that charge, which the compression necessitates in the "viertact" or four-cycle engine.

The invalidation of these claims has reduced the value of the Otto patents simply to the discovery of the before-mentioned details of construction, chief of which is the admission slide; this, and the long axial ignition port must not be infringed. The Körting gas-engine has neither an axial ignition port, since the port enters at the side of the cylinder, nor has it any slide whatever. The gas and air are drawn in through valves, and the arrangement for igniting is one which has been patented and used for some years. The firm of Körting Brothers, therefore, to whom the merit is due, of having conducted this case against the Deutzer Gas-Engine Works, with all imaginable pains and energy for more than three years, is now in a position to proceed with the manufacture and sale of their engines without interference.

Re The West African Telegraph Company, Limited.—Before Mr. Justice Pearson, Chancery Division of the High Court of Justice, Saturday, February 13th. A petition was made for the reduction of the capital of the company. The capital of the company, as fixed by the memorandum of association, was £1,000,000 in £10 shares. Of these only 2,000 shares have been issued, and nothing has been paid upon them. The articles of association authorised the company by special resolutions to reduce its capital, and a special resolution has been recently passed to reduce the capital to £400,000, in £10 shares. The petitioner asked for the confirmation of the reduction by the Court. By the leave of the Court the petition was brought on for hearing without any previous reference to Chambers for directions. There had been some preliminary advertisements of the petition. There was an affidavit stating that, with the exception of some small sums due for wages, the company had only one creditor for a sum of £3,800. This creditor had been served with notice of the petition and now appeared by counsel and consented to the proposed course. No prospectus had ever been issued of the company, the shares which had been issued having been subscribed for privately.

Mr. Everitt, Q.C., and Mr. W. Latham asked for the confirmation of the reduction, that the use of the words "and reduced" might be dispensed with, and that there should be no inquiry in Chambers as to creditors, and no further advertisement of the petition.

Mr. Stirling, for the creditor who had been served, assented.

Mr. Justice Pearson said that he felt some difficulty in dispensing with the use of the words "and reduced," because he thought that the public, who might be inclined to subscribe for shares, ought to know that there had been so large a reduction of the original capital. His Lordship also doubted whether he ought to exercise his discretion by dispensing with an inquiry in Chambers as to creditors. His Lordship said he would confirm the reduction, and would, upon an affidavit being filed that no prospectus had been issued of the company, dispense with the use of the words "and reduced" and with a reference to Chambers. The minute must be advertised in the *London Gazette*, and in *The Times* and the *Standard*.

Anders v. Schofield.—Schofield v. Anders.—These two actions, brought this week in the Lord Mayor's Court, were tried together, because the cause in each case arose out of the same matter. Mr. George Lee Anders said that he was an electrician. Last year he was desirous of going to America, and he asked Mr. Schofield, whom he had known for some time, to go with him. He (witness) offered to pay the expenses of the passage out, and then if anything "good" was to turn up Mr. Schofield should share in it. Plaintiff had a patent for a telephone, which was free from the Bell and Edison patents, which he thought he might be able to sell in the United States. Mr. Schofield lost his money playing "poker" on the passage out, and plaintiff had to advance him some, but he was not claiming on that account now. They did not do much business in America—only an hour or two, nearly the whole of the time being spent in pleasure. Shortly after they came back Mr. Schofield called at his office saying that he was in want of money, and asked plaintiff to lend him £200. Plaintiff lent him £50, and that amount he now claimed. The other amount of his claim, £15, was the balance of a bill of £65, which had been given by the defendant's firm, and which had been made over to the defendant to pay. The learned Judge ruled that the second half of the plaintiff's claim would have to be struck out. Mr. Schofield's version was that Mr. Anders offered him £500 and all his expenses if he would accompany him to the United States. Mr. Anders told him that the patent in America would be worth a hundred thousand dollars, and that he would not be able to conduct the arrangements in his own name, in consequence of his connexion with the London and Globe Telegraph Company, and that, therefore, he could afford to give him £500 for going with him. Witness never borrowed £50. He went to Mr. Anders and told him that as he had given up a position worth £500 a-year, he was in want of money, and would be glad to have the £500 he had promised. Mr. Anders then gave him £50 on account. The jury found for Mr. Anders in both cases.

Otto v. Steel.—This was a motion in the Court of Appeal to stay execution in a patent action pending an appeal. The defendant admitted infringement, and based his defence on the alleged invalidity of the claims in the patent. Dr. Otto had succeeded in a previous action of "Otto *v.* Lidford," in the Court of Appeal, in establishing the validity of his patent; but in the action against Steel a large amount of fresh evidence was adduced with a view of showing that the court in the former action was misled as to the scientific facts. The motion was made in the first instance before Mr. Justice Pearson. His Lordship refused to suspend the operation of the judgment, intimating that he had the less hesitation in doing so because the Court of Appeal, having control over the appeal business if it were considered a fit case, could advance the appeal. The defendant appealed, but the court refused to comply.

In Re The British Electric Light Company, Limited.—In the Chancery Division, on Saturday last, Mr. Justice Pearson made an order winding up this company. On Wednesday Mr. Rylands applied to the Court (*ex parte*) for the appointment of a provisional liquidator. The landlords, he said, had put in a distress upon the effects of the company, and threatened to sell to-morrow. It was thought that the best course would be to appoint a liquidator, who would pay the amount levied for, which was £200, if he thought fit. Mr. Justice Pearson: I shall not turn out the landlord, as I do not know that the liquidator will pay the money. You can have an injunction to restrain him from selling the goods until Saturday, and give short notice of motion for that day. Mr. Rylands: Is that necessary? Mr. Justice Pearson: Yes; as I do not know what the landlord may have to say.

Siemens Brothers & Co., Limited, v. The Assessment Committee of Woolwich Union.—This was an appeal in the Court of General Assessment against the valuation of large works covering an area of 6½ acres and having a Thames frontage of nearly 500 feet, at Woolwich, which have been specially constructed and used for manufacturing the largest marine telegraph cables. The figures in the list were—gross value, £6,750; ratable, £4,500; and the appeal was to reduce to gross £4,200, and ratable £2,800. After evidence had been given by Mr. Ryde and Mr. Spencer Chadwick for the appellants, and by Mr. Morris, Mr. Cross, and Mr. Dinwhiddy for the respondents, the Court reduced the gross value to £6,000 and the ratable value to £4,000 without costs.

Re The International Electric Company, Limited.—In the Chancery Division of the High Court of Justice, on Saturday, an application was made to Mr. Justice Pearson to continue the voluntary winding-up of this company under a supervision order; and his Lordship acceded to the application.

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NOTES.

The Electric Light in the Royal Navy.—A series of experiments have been carried out on board H.M.S. *Polyphemus*, at Portsmouth, in signalling with the electric light. Whilst the vessel was lying alongside the Slips Jetty, in the dockyard, communication was carried on with the flagship *Duke of Wellington*, lying in the harbour. This is the first time these experiments have been made at Portsmouth, and the result was looked upon as highly satisfactory. Commander R. W. White, from the Admiralty, has made a successful trial of the electric light apparatus on board the *Acorn*, sloop, Lieut. R. P. Bowden, at Devonport. He has since conducted trials on board the *Royalist*, corvette, at Devonport, and the *Woodcock*, armed tug, at Keyham. In each case satisfactory results were obtained.

The Electric Light at the Newcastle Election.—Considering the late hour at which the poll at the Newcastle election last week would probably be declared, and the inefficiency of gas illumination in St. Nicholas's Square for such an occasion, the authorities decided to bring the electric light to their aid. The arrangements were placed in the hands of Messrs. J. H. Holmes and Co., electrical engineers, of Newcastle. A portable engine was placed within a wooden structure erected in the Bigg Market, to work two powerful dynamos. Each dynamo worked a large arc lamp, the current being conveyed by wires taken from the dynamos to the top of the Town Hall. The lamps were supported by poles projected from the front cornices of the Town Hall. Each gave a light of 8,000 candle-power, and was so fixed that its light fell immediately on the board placed for receiving the numbers indicating the result of the poll. At a quarter-past six the lamps were lighted for a few minutes, and proved completely satisfactory. When they were lighted later on, they threw the gas lights into the shade, and brilliantly illumined the square of upturned faces beneath. The arrangement, considering the excitement which prevailed at the declaration of the last poll, says a local paper, was quite requisite, and reflected great credit on the forethought displayed by the authorities.

Gas Lighting for Ships.—The Plymouth correspondent of the *Times* states that it is very probable that experiments will shortly be made for the purpose of ascertaining whether gas can be used for illuminating small vessels of the Navy that are not at present fitted with the electric light. It is asserted by the promoters of the scheme that a sufficient amount can be stored on board the ships without materially interfering with their general stowage. Cleanliness, cheapness, convenience, and safety are claimed as the advantages of the system, but naval officers are rather sceptical about its practicability. We, for our part, are rather sceptical about its safety. Experiments are being made round the coast with buoys, and up to the present time the results have been successful.

The Inverness Telephone Exchange.—Twelve months have now passed since the Inverness Telephone Exchange was opened for business. Beginning with 46 subscribers on its list, the number at the close of the year has increased to 67—an increase of 21. The total number of messages which have been transmitted through the Exchange during the year reached the grand total of 64,525. As the average time taken to transmit each message was about three minutes, and as 300 words can easily be exchanged in that time, it is calculated that no fewer than 19,357,500 words have been exchanged between the subscribers during the year. In all the public offices the value and usefulness of the telephone as a means of communication is now fully understood, and duly appreciated. The manager, Mr. R. C. Bennett, deserves credit for the manner in which the exchange has been conducted.

Telephone Companies in America.—It is stated that quite a number of opposition telephone companies are springing up in various parts of America as a direct result of the Government's decision to go into the matter of the validity of the Bell patent.

Telegraph and Telephone Wires.—At the last quarterly meeting of the Andover Town Council the Town Clerk read a letter from the Telegraph Inspector at Salisbury, asking the Council's permission to erect two telephone posts in Weyhill Road, as there was a disturbance of the current along the telegraph wires by the present arrangement. If such consent were given the damage caused to the roads would be made good. Permission was granted conditionally upon the poles being of iron.

Trial Trip of a Cable Ship.—The trial trip of the twin-screw steamer *Mirror*, built by Messrs. R. Napier and Sons, at Lancefield, for the Eastern Telegraph Company, took place on Friday last in the Firth of Clyde. Built in accordance with designs by Mr. Joseph Birnie, the vessel is specially adapted for laying and repairing the company's submarine cables. She is built of steel, and is of the following dimensions :—Length, 250 feet ; breadth, 34 feet ; depth, 25·4 feet ; the gross tonnage being about 1,500 tons.

Foreign Electrical Agency.—Mr. Ernesto Danvers, A.S.T.E.E., Inspector-General of Colombian Telegraphs, writes from Bogota, that he has opened an agency there for the securing of patents, privileges and contracts for electrical materials and work ; and for supplying all information that may be required by firms intending to carry on business in the country. He mentions that there is a grand opening for the electric light.

The Society of Telegraph Engineers and Electricians.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, S.W., on Thursday, February 25th, 1886, when the discussion on "The self-induction of an electric current in relation to the nature and form of its conductor," by Prof. D. E. Hughes, F.R.S., will be continued.

Tramcar Propulsion.—The articles "On Electric Locomotion" which appeared in the last and current numbers of the REVIEW, are well worthy of careful study by those who adhere to the conductor system of electrical propulsion. Mr. Reckenzaun has a happy way of making his papers readable and the principles contained therein easy to be grasped.

An Electric Furnace.—In our next issue we hope to give at length an illustrated description of the Cowles electric furnace, for the production of aluminium and its alloys.

Secondary Generators or Transformers.—The Zipernowski-Déri apparatus to which Mr. Déri alludes in his lecture on "Alternating Currents," was minutely described and profusely illustrated in our issues of August 1st and 8th, 1885.

The Colchester Installation.—We shall be glad to know how many lights, if any, are now being operated in Colchester by the B. T. K. system.

Dynamo-Electric Machinery.—We would commend to the notice of our readers the comments to be found on our first pages on the book of Professor Silvanus Thompson.

Royal Encouragement of Science.—The King of the Belgians has just instituted an annual prize of 25,000 francs in order to encourage the publication of works of an intellectual order. This prize will be applied, in 1889, to a competition for the best work on the progress of electricity, as a motive power, as a means of illumination, and on the application to which it can be made in the future.

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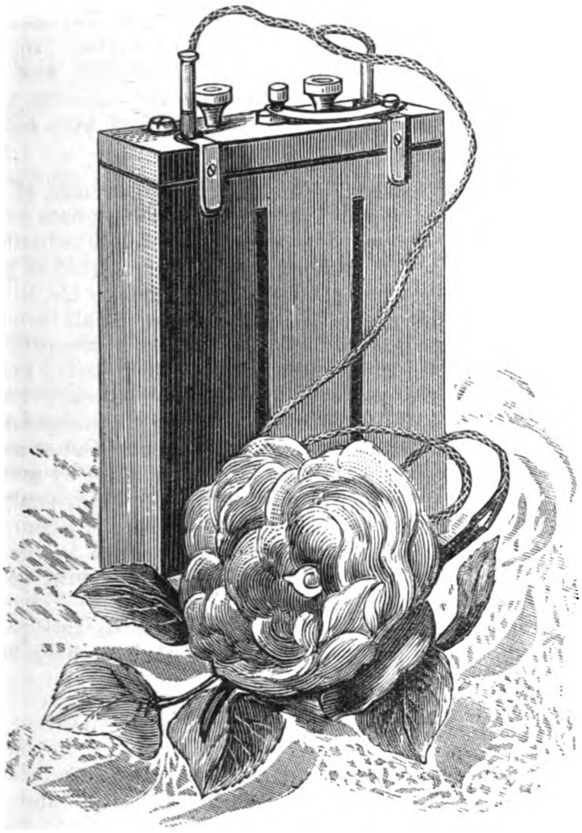
Pocket Primary Batteries.—In response to our enquiry for particulars of the above we have had two sizes of a new battery sent us for inspection. The apparatus consists of a vulcanite case divided into three cells, the elements in which are silver and zinc, excited by a special mercurial solution. The No. 1 size, which we illustrate, can be very readily carried in the pocket, being only 1 inch thick by 4 inches high and 3 inches wide; it is made perfectly watertight, weighs 1 lb. and holds about half-a-pint of solution. A switch attached to the battery will turn on or extinguish the light at pleasure. The parts are interchangeable, and the whole battery can be easily taken apart for renewals, &c. The No. 2 size is identical in



general form with No. 1, except that it is smaller, and weighs only half a pound. This size can quite readily be carried in the waistcoat or breast coat pocket, thus making it specially suitable for electric jewellery, &c. We tried the No. 1 size with one of Messrs. Woodhouse and Rawson's hair filament lamps, mounted inside a white rose; it ran continuously, without any appreciable falling off for a little over 2 hours. This is so far the best battery which we have yet seen for the purpose, and the ease with which it can be recharged certainly recommends it as all that can be desired. This battery has been introduced by the Woodhouse and Rawson Electric Supply Company, and may be inspected at the sample room of that company.

Society of Arts.—On Wednesday evening a paper on "Some Points in Electrical Distribution" was read at the Society of Arts by Prof. George Forbes, M.A., F.R.S.E. Prof. W. Grylls Adams, F.R.S., was in the chair, and the paper was received with attention and applause.

The Gramme Patents.—The Gramme patents having expired in France, dynamos have become cheaper in that country. The workshop dynamo (Gramme's *type d'atelier*), which used to cost 1,500 francs (£60), and lately cost 1,200 francs (£48), is now to be had for 600 francs (£24).—*Gas and Water.*

Telephonic Extension.—Telephonic communication has been established between Glasgow and Airdrie.

The Brighton Electric Railway.—At a recent meeting of the Watch Committee of the Brighton Town Council, a letter was read from Mr. Councillor Challis, inquiring why the electric railway car was not licensed and held amenable to the bye-laws in the same way as any other conveyance plying for hire. The town clerk reported to the committee that he had replied to Mr. Challis, informing him that Mr. Volk's electric car was neither a hackney carriage nor a stage carriage plying for hire in the streets of the borough, and did not, therefore, require a licence. The committee approved of the course pursued by the town clerk.

Working Guns by Electricity.—The question of training and working heavy guns by means of electrical motors has for some time occupied the attention of the War Office authorities, who have carried out a series of experiments. The system of employing small motors, actuated by a dynamo machine driven by a steam engine placed under cover in a sheltered position, will probably be adopted in preference to the present plan of transmitting the motive power by means of shafting. It is understood that the guns of the Spithead forts are to be immediately fitted with the new electrical training gear.

Electric Clock Control.—Clocks controlled by electricity are proposed to be erected in Birmingham, in twenty conspicuous places. The clocks, which will be public, will be illuminated by night. The town council estimate the cost of establishing these twenty clocks at £2,500, and the cost of maintenance to be about £200 per annum.

International Exhibition at Edinburgh.—One of the features of the exhibition will be the display of different systems of electric lighting. The incandescent lights in the main corridor are to be supplied by Messrs. King, Brown & Co. In the permanent building, as well as in several of the side courts, the Thomson-Houston system is to be introduced, while other sections of the exhibition are to be lighted by the Gülcher Electric Light Company, the Brush Light Company, and Messrs. Andrew & Co., Glasgow. The lighting of the grounds is still under consideration. Running parallel with the middle Meadow Walk an electric railway is to be fitted up by Mr. Holroyd Smith, of Halifax.

Lecture.—On Saturday week Mr. J. G. Fairweather, B.Sc., C.E., Lecturer on Engineering at Heriot-Watt College, Edinburgh, delivered a lecture on Domestic Electric Lighting at St. James's Hall, Edinburgh. The lecture was illustrated with a number of electric lamps and apparatus, provided and fitted up by the Scottish Electric Light Company.

The Dire Effects of the Electric Light.—"Sunshine," it is known, has a powerful and peculiar effect upon some mortals, causing a staggering gait and a rambling mode of thought and utterance; we are now convinced that the electric light, when of sufficient power, is capable of producing similar phenomena. A young man recently "went out for to see" Sir David Salomon's 60 volt, 40 ampère, 2,400 watt lamp at Broomhill, and he tells the awful story of what resulted in the *Maidstone and Kentish Journal* in the following words:—"A most conspicuous object for very many miles around Southborough is now the new electric light, equal to 15,000 candle-power, which Sir David Salomons has lately erected on the summit of his lofty astronominal tower observatory. Its effect over the snow-covered country last week was especially brilliant and vivid, assisted out of the carriage little the worse, except for the shock. The carriage had to be removed for repairs, the lady going home by other means. The milk cart, which was from Penshurst, was also rather damaged, but the driver fortunately escaped unhurt."

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Ocean Currents.—The question of ocean research is one of general interest, and all efforts in this direction, whether undertaken by private individuals or by governments, should meet with the warmest sympathy. The geographer, the navigator, the scientist, and last, but not least, the telegraph engineer, are alike interested in ocean exploration. We give our readers the substance, naturally much condensed, of a long article in the French illustrated paper *L'Illustration* of February 13th, on the subject of ocean currents, and more especially with regard to some experiments lately made in the neighbourhood of the Azores on the direction of the Gulf Stream. It appears that in July of last year the Hereditary Prince of Monaco, accompanied by Mons. G. Pouchet, professor at the Paris Museum, started in the Prince's sailing yacht *L'Hirondelle*, with the intention of crossing the Gulf Stream somewhere in the vicinity of the Azores, and dropping at intervals floating vessels containing the following notice in French, with full instructions in Russian, Norwegian, Danish, English, German, Dutch, Spanish, and Portuguese: "With the object of studying the ocean currents, assisted by the Municipal Council of Paris, this document has been thrown into the sea under the direction and in the presence of His Highness the Hereditary Prince of Monaco, on board his yacht the *L'Hirondelle*. Whoever finds this paper is requested to hand it to the authorities of his country to be transmitted to the French Government, at the same time stating with all possible details the place, date, and circumstances connected with the finding of this document.

(Signed) ALBERT, Hereditary Prince of Monaco.

(Signed) G. POUCHET, Prof. at the Paris Museum."

Each copy of the above notice, torn from a book in which a counterpart is kept, carries a serial number, and is enclosed in a glass tube hermetically sealed. The notice is rolled up with the printed matter outside, so that its polyglot character may be seen without breaking the glass. The floating vessels containing the tubes were of three patterns. 1. Ten copper spheres, 0·30 metres in diameter, composed of two semi-spheres, screwed together over an India rubber joint. 2. Twenty 16-litre barrels, with exceptionally strong staves, bound with iron hoops, and tarred inside. 3. One hundred and fifty ordinary bottles, the corks protected by an India rubber cap. The barrels were filled with chaff, and were ballasted with cast iron weights of about 20 kilos. each, attached by wire to wooden hoops on the barrels. Some of the bottles were thrown overboard on July 27th, commencing at a position about 110 miles N. 27° W. of Corvo (the most westerly island of the Azores), and were deposited at about a mile apart. The barrels and spheres were then let go at intervals of two miles, and the remainder of the bottles were then got rid of. The course made during the immersion of the vessels was N. 14° W. over a distance of 170 miles. Out of the 180 floating vessels thrown overboard, six have been recovered up to date. Numbers 9, 133 and 136 were picked up at San Miguel. Number 22 at Santa Maria; number 1 on the north side of Pico; and number 30 at Terceiva. The description given is not very clear as to how the vessels were immersed with regard to their numbers, nor are the dates of recovery given, but it is deduced from the vessels let go nearest to the Azores having taken the longest time in reaching those islands that the Gulf Stream forms a considerable eddy round the islands. From these experiments it is also claimed that :—1. Up to a distance of 300 miles to the N.N.W. of the Azores, the Gulf Stream, instead of having a N.E. direction, as generally supposed, has actually a direction of S. 35° to 40° E. 2. No part of the Gulf Stream proper reaches the coasts of France. That is to say, no portion of it from the positions where the vessels were let go. 3. If any part of the Gulf Stream actually reaches the French coast it must be looked for to the north of the forty-second parallel, but it is not probable that the Gulf Stream has any effect north of lat. 40°. 4. The mild climate on parts of the French coast is due to surface currents influenced by prevailing winds. Considering that only six vessels out of the 180 immersed have been recovered, and that the experiments have been carried on comparatively close to the Azores, and therefore, subject to local influences, it is rather premature to express any opinion as to the results so far obtained, but, whether these experiments prove valuable or useless, the Prince has certainly taken a step in the right direction, and he deserves every commendation for his endeavours.

Post Office Telegraphs.—A return has been issued, in accordance with an order voted in the House of Commons, showing the gross amount received and the gross amount expended in respect of the telegraph service from the date of the transfer of the telegraphs to the State in 1870 to the 31st day of March, 1885. From this it appears that the total receipts in 1885 amounted £1,784,414, which sum was less by £36,350 than the expenditure for the same year, £1,820,764. In the year 1884 the expenditure was £1,789,223, and the deficit then was £19,697. These are the only two years since 1870 in which the expenditure has been higher than the receipis.

Tests of Dynamos.—Mr. George Hookham, of the firm of Chamberlain and Hookham, Birmingham writes (too late for insertion in our correspondence columns): —"It seems a pity that a suggestion started in your REVIEW by Mr. Crompton, and seconded by Mr. Elwell of Wolverhampton, should be allowed to fall through. I refer to the proposal for a dynamo competition. Would not you, Sir, be willing to do something to forward such a movement? A good preliminary would be to collect and collate opinions as to the *points* of dynamos, their relative value, and the method of ascertaining them. These might be contributed by makers and others, and if you would undertake their analysis, much would be done to clear the ground for a competition. My firm, for example, would be glad to furnish such a list of suggested *points* if others would do the same."

We shall be pleased to do whatever is in our power to forward this matter, and shall be glad to hear from all manufacturers on the subject.

Country Agency.—Messrs. Walker & Olliver, of Cardiff, Leeds, and Newcastle, have been appointed agents for those districts by Messrs. Heap and Stuart for the sale of their incandescent lamps and the Buffalo carbons, and other specialties.

NEW COMPANIES REGISTERED.

Gas and Light Company of Portugal, Limited.—Capital £100,000 in £5 shares. Objects: To carry on in Portugal, the Portuguese possessions, or elsewhere, the business of gas manufacturers and electrical engineers and every other business connected with the manufacture of gas and electricity. Signatories (with one share each): Hy. Cade, 19, Runton Street, Holloway; G. Pye, 4, West View, Hendon; A. Stein, 17, Great Winchester Street; F. J. Jones, 257, Uxbridge Road; F. Howell, Dunstable; F. O. Moore, 10. Adelphi Terrace; H. Ogle Moore, Addlestone, Surrey. The first directors are the Hon. Wm. Arnnand, Richard Wood, J. P. and W. Fletcher Gordon; qualification 20 shares; remuneration £500 per annum, with £200 per annum additional for each concession taken over by the company after the first. Registered 16th inst., by George Daniels, 7, Woodford Road, Watford, Herts.

Simplex Electrical Syndicate, Limited.—Capital £6,000 in £50 shares. Objects: To purchase the following letters patent, viz.: No. 3,905, dated 25th February, 1884; No. 15,030, dated 14th November, 1885, and No. 7,390, dated 17th June, 1885, granted for improvements in electric arc lamps; and No. 12,840, dated 26th October, 1885, for improvements in secondary batteries. Signatories (with five shares each): C. L. Wingfield Fitzgerald, 4, Hercules Passage, Threadneedle Street; A. H. Baker, 31, Throgmorton Street; W. W. Bateman, Cornhill Chambers; R. E. Bateman, Reigate; F. C. Stoop, 46, Penywern Road, Earl's Court; H. Grewing, 26, Queen Anne's Gate; H. B.

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Muir, 192, Cromwell Road, S.W. Registered 15th inst., without articles of association, by Hollams, Son and Coward, Mincing Lane.

Hirsh, Greystock & Co., Limited.—Capital £50,000 in £10 shares. Objects: To purchase the business of Walter Moser, portable electric light manufacturer, trading as Hirsh, Greystock & Co., at 11, Queen Victoria Street. Signatories (with one share each): H. P. Bernard, 107, Cannon Street; F. B. Reynolds, Addiscombe; A. C. Bell, 22, St. John's Grove, Croydon; W. Moser, 11, Queen Victoria Street; C. J. Reeve, 45, Fonthill Road, Tollington Park; G. J. Carringham (electrician), 21, Gilmore Road, Lewisham; R. T. Linford, Rosedale Place, Ealing. The directors (other than the first) will be required to hold £500 of the share capital. The remuneration of the board will be £850 per annum. Registered 15th inst., by A. C. Bell, 11, Queen Victoria Street.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Eastern and South African Telegraph Company, Limited.—The annual return of this company made up to the 21st July, 1885, was filed on the 12th inst. The nominal capital is £400,000, divided into 20,000 "A" and 20,000 "B" shares of £10 each, the whole of which are taken up and are fully paid.

Spanish National Submarine Telegraph Company, Limited.—The annual return of this company made up to the 12th ult., was filed 12th inst. The nominal capital is £500,000, divided into 49,900 shares of £10 each, and 1,000 shares of £1 each; 23,719 of the former have been allotted, and £10 per share has been called thereon. £30 has been received in payment of calls, and £237,160 is considered as paid up. The total amount of shares for which share warrants are outstanding is 2,304.

West London Electric Lighting Company, Limited.—At an extraordinary meeting of this company held at 38, Old Broad Street, on the 19th ult., it was resolved that "A Bill to make further provisions respecting the undertaking of the West London Electric Lighting Company, Limited, and for other purposes," to be introduced into Parliament in the present Session, be approved. The resolution was confirmed on the 9th inst., and registered 12th inst.

Railway Electrical Contractors, Limited.—At a meeting of this company held at 144, Leadenhall Street, on the 3rd December, it was resolved that Article 7 of the articles of association be amended by adding thereto the following words:—"Subject to any such rights or privileges, and to any special directions which may be given by the company in extraordinary general meeting, the shares of the company shall be under the control of the directors, who may sell or otherwise dispose of the same to such persons, on such terms and conditions, whether at a premium or discount or otherwise, and at such times as the directors may see fit." The resolution was confirmed on the 31st December, and registered 12th inst.

Standard Time and Telephone Syndicate, Limited.—The registered office of this company is at 19 and 21, Queen Victoria Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Submarine Telegraph Company, Limited.

THE ordinary general half yearly meeting of this company was held at the offices, 2, Throgmorton Avenue, E.C., on Tuesday, Sir Julian Goldsmid, chairman of the company, presiding.

The report, which was taken as read, stated that the receipts for the six months ending 31st December, 1885, amounted to £64,782 0s. 4½d., being £456 19s. 11d. more than in the corresponding six months of the year 1884, while the expenses have been less by the sum of £75 2s. 4d. The net result of the business for the six months enables the directors to add £8,083 0s. 10d., the usual proportion of the gross receipts, to the reserve fund, and to recommend a dividend at the rate of 14¼ per cent. per annum, leaving a balance of £414 3s. to be carried to the next account. For the corresponding period of 1884 the dividend was 14 per cent., and the balance carried over £377 18s. The receipts from the ordinary traffic for the six months were somewhat less than in 1884, although there were 62,351 more messages transmitted, but the average length of those messages was only 11·44 words against 11·91 in 1884. There has been also a falling off in the receipts in respect to the messages transmitted by the Eastern Company over the wire leased to that company, partly by reason of the reduction in the inland rate of telegrams on the 1st October last. But, on the other hand, there has been an increase in the special receipts from the fresh arrangement made with the Indo-European Company, referred to in the last report, and from an agreement recently entered into with the Commercial Cable Company for the use of a special wire to Havre for the transmission of their French-American messages. The company's cables, as well as those under the care of the company, have, with two exceptions, been worked during the half year without any interruption. The exceptions are the Dieppe Cable and the cable between Salcombe and Brest; the former was broken on the 14th and repaired on the 22nd of December, and the latter was broken on the 25th October and repaired on the 14th December, 1885. In the last report it was stated that the cables during the first six months of the year were also remarkably free from interruption; consequently the repairing ship was in port for many months. The drawback paid by the insurance company at the expiration of the yearly policy in August was £486, or £160 10s. more than the charge for insurance for the six months ending December, 1885. This is the reason for the absence of the usual charge in the accounts under the head of "Insurance of Steamer." The sum of £160 10s. will, morever, be credited to revenue in the next accounts. An International Telegraph Conference was held at Berlin in August, when the company was most efficiently represented by Mr. George de Bunsen. The result of the conference was that some of the telegraph charges were reduced, but the slight modification in the rates between this country and the Continent of Europe will not, it is expected, prejudicially affect the company's revenue. The new rates do not, however, come into operation until 1st July, 1886. All the company's cables, as well as those worked by the company, are at the present time in good working order.

Mr. S. M. Clare, secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, said he thought, on the whole, the report was satisfactory. If they had read it they would have seen, in the first place, that in consequence of the improved condition, especially of the Dieppe cables belonging to the government, which, they would remember, were either partially or completely renewed not long ago, they had had very few breakages in the cables, and the result had been that their ship had been at home for the greater part of the half-year; a curious part of this circumstance was, that the drawback allowed by the insurance company was in excess of the premium they paid; and, therefore, they had no insurance to pay, and the balance went to the next half-year's accounts. The principal repairs had been in the Dieppe cable, in which something over 3¼ miles of new cable had been put, and in the Salcombe, which took 1¼ mile of new cable. These two were done at the same time, so that practically one outing on the part of the ship accomplished all that was required. This was a matter of congratulation. But when he came to other points he was not equally satisfied. He had told them for some time past what was the condition of affairs with regard to the traffic. He had told them that they had a steady increase of traffic, and a steady decline in the length of messages. He held tables in his hand which showed that that increase and decrease continued, for whereas in the half-year which ended on December 31st, 1884, they had 1,428,520 messages, there was an increase in the half-year ending December 31st, 1885, to 1,490,891. The words had increased from 17,007,766 words to 17,062,135; but the average length of the messages, which was 11·91 words last year, had now decreased to 11·44, showing that the system of compressing messages was still going on. He had often said here, and must now repeat, that he could not tell where the limit of fall in this respect was. Of course, there was a limit somewhere, but they had not yet been able to ascertain where, and he noticed that in the returns for the month of January there was a still further decline in the average. This was an unsatisfactory side of affairs, and he had thought it his duty to put all the information he reasonably could before the shareholders upon this subject. In the report they referred to the Telegraph Conference, and he should like to say, on behalf of the board, that Mr. George de Bunsen represented the company at Berlin with great success. He belonged to a family of diplomats, and they were fortunate in having so able a man to represent the company. The alterations made in the international charges were comparatively small, and would not do this company any injury; those alterations would come into operation on July 1st. They had lost one newspaper, *Le Telegraphe*, a French paper; and the *Daily News* had leased a wire for three hours a night, showing that it is an enormous advantage to the Press to be able to use a wire for their own purposes without the knowledge of anyone else. The company assisted very materially the spread

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of information over the whole world in this way. Altogether, he thought their affairs were in a satisfactory state, and the dividend the directors were able to recommend was a good one, under all the conditions.

The Right Hon. Robert Bourke, M.P., seconded the adoption of the report.

A Shareholder remarked that the merchants of Liverpool were complaining of their lack of facilities for telegraphing to the Continent, and he desired to know if the matter affected this company.

The Chairman stated that two or three years ago, as now, the Liverpool merchants wanted a special cable to carry their messages; but the Post Office and this company went into the matter, and found that the traffic would not be nearly sufficient to justify a separate cable for the purpose. The complaints of delay affected the landlines, and not the submarine system; but some of those complaints, upon being investigated, proved not to be well-founded.

The motion was then put and carried unanimously.

The Chairman moved: "That in accordance with the recommendation of the directors, a dividend for the half year to 31st December, 1885, at the rate of 14½ per cent. per annum, less income tax, be declared, to become payable on March 1st."

The Hon. Ashley Ponsonby seconded, and the motion was carried, a vote of thanks to the Chairman thereupon terminating the meeting.

The Maxim-Weston Electric Company, Limited.

THE directors' report is as follows:—The directors beg to remind shareholders that no allowance was made during the past two years for contingencies such as are referred to in section R of clause 75 of the articles, and they have now deemed it prudent to pass the sum of £3,606 5s. to the credit of a general reserve account.

After making the above reserve the total balance at credit of profit and loss account, including amount brought forward from previous year, is £5,284 19s. 8½d.

The directors recommend the payment of 7½ per cent. dividend, which will leave a balance of £597 9s. 8½d. to be carried forward to next year.

The directors having obtained the sanction of the Court to the reduction of capital, patents account has been reduced to £35,000, which includes outlays during the past year in connection with new patents.

The plant and machinery at factory have been valued in minutest details, as in the case of last year, in the presence of the Chairman, under the supervision of the works manager.

The directors estimate that £600 will cover the total bad debts incurred by the present management, including outstanding debtors.

Owing to the growth and present requirements of the business, the directors have been compelled to look out for larger manufacturing premises, and hope to secure in a few days a suitable factory upon lease, at a moderate rental.

The commodious premises referred to will give much needed facilities for manufacturing and testing purposes, and will effect a large saving in labour—the factory, which consists of only two floors (instead of six, as formerly), containing more than four times the cubic area. The different departments will thus be constantly under the supervision of the manager.

The electrical staff of the company, so as to keep pace with their more enterprising competitors, are constantly engaged in experiments which so far have resulted in great improvements in our systems.

The directors are happy to be able to report a rapid development of the business, and having now established agencies in nearly every quarter of the globe, which their patent rights include, are in hopes of showing a larger balance of profit at the end of the current year.

The Chairman trusts to be of some service in obtaining the removal of restrictive legislative enactments, and is in hopes that the Government will approve of certain amendments to the Acts of 1882, which ought to give a further stimulus to the business.

Balance Sheet, 31st December, 1885.—*Dr.*—To capital issued, £62,500; to calls unpaid, £2 10s.; to creditors, £1,150 9s. 9½d.; to bills payable, £254 5s. 4d.; to reserve account, £3,606 5s.; to profit and loss, £5,284 19s. 8½d.; total, £72,793 9s. 10d. *Cr.*—By patents, £35,000; by machinery and stock at factory, £12,285 14s.; by furniture and fittings at office and factory, £170; by shares in Electric Sun Lamp and Power Company, Limited (£4,625), estimated at 2s. 6d. in £, £578 2s 6d.; by debtors, £12,794 15s. 6d.; by cash at banker's and on deposit, £11,964 17s. 10d.; total, £72,793 9s. 10d.

German Union Telegraph Company, Limited.—The net profit for the year ended December 31st, 1885, after paying 59,408 marks to the reserve funds, and a similar amount to the renewal fund, and paying the dividend on the original preference shares, is sufficient to allow of a dividend of 7 per cent., of which 4 per cent. was paid last month.

Western and Brazilian Telegraph Company, Limited.—Holders of share warrants to bearer are notified that in order to obtain the dividend of 2½ per cent., declared at the annual general meeting on the 21st ult., they must deposit the warrants at the offices of the company.

Great Northern Telegraph Company, Limited.—The numbers are published of 100 debentures of 1883 (series B), drawn at Copenhagen on the 23rd ult., for payment on March 1st, at the offices of Messrs. C. I. Hambro & Son, 70, Old Broad Street, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 12th were £2,646, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th February are £2,551, as compared with £2,339 in the corresponding period of 1885.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, February 11th, Sir CHARLES BRIGHT, Past President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a discussion on Professor Hughes's paper (Inaugural address) on "The Self-Induction of an Electric Current in Relation to the Nature and Form of its Conductor" was commenced.

LORD RAYLEIGH, in opening the discussion, pointed out that Professor Hughes did not use the term "self-induction" in the sense which Clerk Maxwell and others employed it. The term could be expressed as a definite quantity which was independent of the metal experimented on, except in the case of magnetic metals. The element of resistance enters into the question, so that if we call L the self-induction, R the resistance, and T_1 time, then we have

$$\frac{L}{R} = T.$$

The quantity T had been called by him the "time constant." The method of measuring self-induction suggested by Clerk Maxwell was that of obtaining stable balance on a Wheatstone bridge, one arm of which contained the resistance whose self-induction was required, and then making and breaking the battery circuit and observing the throw of the galvanometer needle; the value of the galvanometer constant was observed by obtaining a small permanent deflection. The magnitude of the electromotive impulse when contact was made depended upon the coefficient of induction, and also upon the current. He doubted whether in Professor Hughes's method the two quantities were sufficiently separated. No ambiguity would arise provided the wires dealt with had all the same resistance. Maxwell gives two methods of measuring self-induction, but those methods are probably not applicable to Professor Hughes's apparatus. In Maxwell's book the case of two long parallel conductors was dealt with, an equation of the form

$$\frac{L}{l} = 2\,\mu_0 \log.\frac{b^2}{a_1\,a_1'} + \frac{1}{2}\,\mu + \frac{1}{2}\,\mu'$$

being obtained. In this equation a_1 and a_1' were the respective radii of the wires, μ_0 the magnetic permeability of the air, b the distance between the centres of the wires, and μ and μ_1 the magnetic permeability of the wires themselves. The latter quantities are very high numbers in the case of magnetic metals. He would point out that the quantity, log. $\frac{b^2}{a_1\,a_1'}$, was not correct unless μ and μ_1 were equal. Professor Hughes by his experiments brings out the fact that, in the case of iron, the division of the flat ribbon into strips did not make any difference in the effect, but in the case of copper it does; this is perfectly in accordance with the equation of Clerk Maxwell. The formula before mentioned became considerably modified if the wires were close to each other as then the mutual reaction came into play; this point Maxwell had not dealt with. In the case of two concentric tubes the problem became more easy, and if the space between the tubes was very small, the cylinders of the same material, and also if the cylinders were very thin as compared with their radii, then calling r the common radius and c the thickness, the total section of each ring would be $\pi\,c^2$, and the equation of self-induction would be

$$\frac{L}{l} = \frac{2\,\mu\,c^2}{3\,r^2}\left(1 + \tfrac{1}{10}\,\frac{c^4}{r^4} + \text{etc.}\right)$$

This equation shows that if c is preserved constant, then by increasing the radius *the self-induction may be reduced to any extent we please.* Maxwell in dealing with the problem recognised only two qualities, viz., magnetic permeability and resistance. The question raised by Professor Hughes's experiments is whether there is any effect other than that which is not caused by resistance alone. The carbon and metal results are curious, and the question arises whether the results obtained were in any way due to the form of the apparatus itself. As regards the effects

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observed with stranded iron wire he rather thought that they were due to the strands being separated from each other by a stratum of air, the quantity μ_0, in fact, being very small. The results in the case of copper strand were difficult to understand; they might possibly be due to some facts not yet brought out, though he thought there was probably only a misunderstanding of *terms* and not a new fact discovered. Lightning conductors, it was pointed out, might either act to enable electricity to be discharged with facility or to prevent its accumulation. Speaking of the action of the telephone Lord Rayleigh stated that it had been argued that a certain amount of magnetism was necessary for proper action; this he did not find confirmed by his own experiments. Referring again to the constants μ he pointed out that they only remained so as long as the point of saturation was not attained; after that point they became variables.

Mr. Frank Pope said it was 30 years since he entered the telegraph service; at that early period many phenomena were observed which could not be accounted for. Some of these had subsequently been explained, but others now became evident as a consequence of Prof. Hughes's researches. The burning of coils by lightning, even when the line was earthed close to the coils, was now comprehensible. In the type printer of House, it was noticed that much better work was obtained on a stranded than on a solid wire, though, as far as could be judged at that period, their resistances must have been about equal; at the time the fact was put down to the supposition that the current flowed only over the *surface* of the wire. The discovery that the coils of an electro-magnet, when joined up in multiple arc, gave a much higher speed in Wheatstone automatic instruments than when the same resistance of solid wire was used, was also explicable from Hughes's experiments. In 1876, an automatic system with a Bain recorder was worked over a 100-mile line at a rate of 1,000 words per minute; the wire used was a compound copper steel one. The same speed could not be obtained over an iron wire; but it was not proved that a plain copper wire would not give equally good results, as the experiment could not be tried.

Prof. Forbes pointed out that the case of an earth wire being unable to protect the coils of a telegraph instrument had an analogy in the case of a gun bursting when fired if the muzzle were loosely plugged with snow. The influence of an iron sheathing round a conductor might lead to important modification in the construction of submarine telegraph cables, thus the use of a sheathing of gun metal might enable the working speed to be increased. The self-induction of an Atlantic cable, he pointed out, was enormous. The remark of Lord Rayleigh that all the results obtained by Prof. Hughes had been foreshadowed by Clerk Maxwell, was, he thought, rather hard, as a careful going into the matter would, he was of opinion, reveal that there was more in the experiments than at first sight might be imagined. He considered that the question of the coefficient of self-induction was not the only point to be dealt with, and that new facts had really been discovered. Lord Rayleigh had said that on stable equilibrium being produced, then when induction causes this to be out, a new balance can be obtained. Now, as a matter of fact, this new balance would be different for making and for breaking contact; but Hughes gets a balance which is the same for both. Maxwell's results are not in harmony with those of Hughes. In the case of wires of different thicknesses, the equation for the induction is

$$L = L_1 \frac{dc}{dt};$$

but for a strip we have

$$L = Rc + a\frac{dc}{dt} + b\frac{d^2c}{dt^2}.$$

When the two last terms are equal to 0, then we have the condition for stable equilibrium. The self-induction in the middle of a strip is greater than it is at the edges, and this is still more marked in the case of a cylinder; so that a current circulates in the wire, the direction of which is reversed when the circuit is broken. This consideration completely explains all the phenomena obtained by Hughes. Seventeen facts mentioned in the paper are thus accounted for.

Dr. Hopkinson said that with regard to methods of measuring self-induction, he had suggested one which was a modification of that of Clerk Maxwell, two galvanometers being used, one of which was in the battery circuit. Prof. Forbes had touched upon the distribution of currents in conductors when self-induction takes place; when a current is put on this distribution is not uniform, but changes from the centre to the circumference of the wire or strip. The question of round *versus* flat lightning conductors had, he thought, been completely settled by the experiments of Hughes.

The discussion was then adjourned.

NEW PATENTS—1886.

1916. "Electric wig or other head dress." G. Epstein. Dated February 10.

1946. "Diaphragms for telephones, phonographs and the like." G. C. Taylor. Dated February 10.

1947. "Phonographic or sound or speech-producing implement for use in lighthouses, &c." G. C. Taylor. Dated February 10.

1999. "Electric lamps for use for lighting in mines, railway carriages, &c." J. W. Swan. Dated February 11.

2002. "Applying electricity to the scalp or head for curative or other purposes." G. Lichtenfeld. Dated February 11. (*Complete.*)

2012. "Regulating apparatus for arc electric lamps." J. D. F. Andrews. Dated February 11.

2013. "Electric lamps." J. D. F. Andrews. Dated February 11.

2067. "Automatic electrical circuit switches." C. A. Gisborne. (Communicated by F. N. Gisborne and D. H. Keeley.) Dated February 12. (*Complete.*)

2080. "Electric switches." A. Bernstein. Dated February 12. (*Complete.*)

2081. "Telephonic apparatus." L. de Combettes. Dated February 12. (*Complete.*)

2169. "Army electric signalling lamp." A. Lovell. Dated February 15.

2193. "Fittings of mechanical telephones." W. J. Burnside. Dated February 15.

2242. "Electro stylo aureo graphic pen and pencil." C. A. Teske. Dated February 16.

2268. "Transmitting, reproducing and recording speech and other sounds." C. A. Bell. Dated February 16.

2282. "Separating magnetic from non-magnetic substances." H. H. Lake. (Communicated by H. Kessler.) Dated February 16.

CORRESPONDENCE.

Telegraphing to and from Moving Trains.

Apropos of an article on this subject in your issue of December 19th, 1885, I beg the favour of your inserting in an early number the following words which were spoken in a lecture as far back as 1838:—

"And now I have a few words to say upon what must be considered another application of electricity, namely, the purposes it will answer upon a railway, for giving notices of trains, of accident, and stoppages. The numerous accidents which have occurred on railways seem to call for some remedy of the kind; and when future improvements shall have augmented the speed of railway travelling to a velocity which cannot at present be deemed safe, then every aid which science can afford must be called in to promote this object. Now, there is a contrivance, secured by patent, by which at every station along the railway line, it may be seen by mere inspection of a dial, what is the exact situation of the engines running, either towards or from that station, and at what speed they are travelling.

"At every railway station there will be a dial, like the face of a clock, on which, by means of a hand, or pointer, it may be seen where any particular train may be at any particular instant. Every time the engine passes a milestone, the pointer on the dial moves forward to the next figure, a sound, or alarum, accompanying each successive movement.

"Not only this, but if two engines are approaching each other, by any casualty, on the same rails, then, at a distance of a mile or two, a timely notice can be given in each engine, by a sound, or alarum, from which the engineer would be apprised to slacken the speed; or, if the engineer be asleep, or intoxicated, the same action might turn off the steam, independent of his attention, and thus prevent an accident."

The above words will be found printed at pages 407–8 of my "History of Electric Telegraphy." At the time they were uttered (in 1838) probably not one man in a million in England believed in the possibility of electric telegraphs of any kind. All honour, then, to the memory of Edward Davy, their gifted author.

The MSS. from which these passages are taken, and which I have had the rare fortune to bring to light after an interval of nearly fifty years of oblivion, are now in the library of the Society of Telegraph-Engineers and Electricians, and will well repay perusal. In the words of a distinguished electrician:

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"They show that the humble occupant of 390, Strand, London, was not only an ingenious inventor, but a clear-headed and far-seeing man. Of his peculiar, and even wonderful, grasp of the properties of electricity there can be no question. One cannot help feeling, as one reads the highly suggestive notes and confident anticipations with which his memoranda and letters are crowded, that had he remained in England to steer the destinies of the electric telegraph it would have made more progress than in other hands it actually did make. What he accomplished was clearly the outcome of his own original mind, and what he predicted as possible, but allowed to be fulfilled by somebody else, also belongs to him."

I may mention that Edward Davy died on the 26th January, 1885, but not before he had received a due acknowledgment of his undoubted claims.

J. J. Fahie.

Teheran, Persia, *January* 16*th*, 1886.

The Use of the Tangent Galvanometer.

It may interest your readers to know that the tangent galvanometer can be rendered twice as sensitive, and have a greater reading range by turning the coil so that the needle stands normally at 100 divisions on the tangent scale, or 60° on the degrees scale.

A current which would under ordinary circumstances deflect the needle from zero to 100 divisions on the tangent scale, would deflect the needle from the new zero (100) to 100 divisions on the other side of the scale.

The intermediate tangent divisions would accurately represent intermediate strengths of current; the tangent could, therefore, in its new position be shunted so as to give half its ordinary resistance, and still admit of 100 divisions being obtained with the new position, as against 100 divisions in the old position with a higher resistance in the galvanometer circuit.

A further advantage is gained, in so far as in the ordinary method readings of 80 to 100 divisions must be taken on a part of the scale which is difficult to read from; but a similar reading on the new method would be taken on the larger tangent divisions with great ease.

When an instrument with thick coils is used, and where the external circuit is so low that a battery liable to polarisation is falling in force during the time the needle is swinging round to its point of maximum deflection, the final deflection is less than that which would be indicated if polarisation had not interfered. To enable an instantaneous reading to be taken, a bar magnet may be placed so as to deflect the needle and to indicate approximately the number of divisions which the current will give; and when the current is put on, the magnet should be simultaneously removed. A few trials will enable a very close estimate to be formed of the deflection which would be obtained if polarisation were not present.

A. E.

London, *February* 10*th*, 1886.

Telephone Patents.

The splendid contribution to electrical science *given* to the world by Professor Hughes in his masterly inaugural address to the Society of Telegraph Engineers, is quite on a par with Faraday's noble example of 1831, but with this difference, Faraday *gave* his discoveries freely, contenting himself with expressing his confident belief in their ultimate "full development"; but he did not live to see the carrying out of what he was so sure about; Professor Hughes, on the contrary, has lived to see his earlier gift—the discovery of the microphone—utilised to the enhancement of another man's work in a degree that is most marked, for where would have been the value of the Bell telephone had not the microphone come to its aid, as discovered by Professor Hughes? True it is that Edison's patent claim is made to cover it, yet the working instrument of to-day is based upon Hughes's principle rather than Edison's, which, at best, was but a clumsy arrangement, and is now practically abandoned. Yet, for all the benefit—the world wide benefit truly—which his discovery has conferred, and the vast commercial value bestowed, I wonder whether Professor Hughes is to-day one penny the richer? And this brings me to the point noticed by your correspondent "Telephonist," to wit, that if the Bell telephone were upset to-morrow the value to the public would be but little, as *the telephone, used as a transmitter, is a failure;* and that so long as inventors work inside "the combination of a diaphragm with a tension regulator," the Edison claim will be held as good against them.

By the way, Mr. Editor, how would "the combination of a diaphragm with a *current generator*" meet the case? To my provincial mind it looks like a new departure, if it can be accomplished. That well posted telephonic record, Major Barney, when he sees this might perhaps venture an opinion, as I feel sure that, though he is in New York, he yet keeps himself well posted in all matters *re* telephones that appear in the ELECTRICAL REVIEW.

Better instruments will, doubtless, be the outcome of Professor Hughes's more recent discoveries; but in order to break down the monopoly of the firm that will not sell telephones out and out at a reasonable price, efforts must be directed specially to a transmitter free of the Edison. Then the field will be opened, for, with the Glasgow receiver free, the Bell form can be dispensed with.

"Combination."

10*th February*, 1886.

Cable Messages.

Will you please inform me if you are *positive* the article in relation to the "Communication between Europe and this country" has been correctly "set up" by your compositor? May I infer from the above that the only cable working between Europe and America was the Mackay and Bennett Cable? Will you please tell me where Coney Island is located? The article upon the quickest time on record is rather difficult to understand. Will you please tell me where the office is located occupied by the parties to whom that quick cable message was directed? And if it is possible to learn the number of *letters* constituting the message? Is the resistance of the Commercial Cable known? I should like to be informed what current is required to charge the cable sufficient to receive an unmistakable signal? And how many times the circuit had been opened and closed during the transmission of the message, also the length of time occupied in delivering, transacting the business, and getting back with the answer. This is not only the quickest time on record, but the most marvellous feat in the annals of electrical communication, and I believe it is safe to say that no other in the world of the same length will ever do it again.

Bonco.

London, *February* 15*th*, 1886.

[We must really refer our correspondent to the source from whence we derived our notes, and which is conspicuously mentioned therein.—EDS. ELEC. REV.]

The "Otto" Gas Engine Patents.

We beg to hand you, enclosed, a pamphlet which may be of interest to you. Numerous actions were brought against Messrs. Körting by the holders of the Otto patents in Germany.

In order to get the matter decided once for all, Messrs. Körting brought, as was their right according to German law, an action to declare the Otto patents null and void. This you will see they have succeeded in, the only points remaining to Otto being certain mechanical arrangements as used in his special engine. This decision has been given by the "Reichsgericht,"

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or highest court in Germany, from which there is no appeal, consequently all the other actions of Otto fall to the ground.

Korting Bros.
P. M. Mulready.

London, E.C., *February* 11*th*, 1886.

[A reprint of the pamphlet to which our correspondent refers may be found in our other columns.—Eds. Elec. Rev.]

Discovery of Electro-Magnetism.

In your issue of December 19th last, Mr. Lutteman devotes over two columns of your valuable space to a refutation of the Romagnosi claim to the discovery of electro-magnetism. This I beg leave to state is, or should be, a work of supererogation, at all events for English readers who have access to my "History of Electric Telegraphy" (Spon, 1884), where the subject is exhaustively treated, pages 256 to 274. Mr. Lütteman might consult these pages with advantage.

If any credit attaches to the settlement of this long-disputed question I claim it for myself, and I appeal to you to endorse my claim, which I feel you will do after a reference to the above-mentioned pages of my book.

Although it is no discredit to Oersted, it should be known that his discovery was the result of a happy accident—see note, page 273 of my "History."

J. J. Fahie.

Teheran, Persia,
January 15*th*, 1886.

[We think Mr. Fahie's claim is fairly made out.—Eds. Elec. Rev.]

Re F. V. Andersen's Formulæ.

Under problem F in the above very interesting and instructive practical formulæ, which gives the diameter of wire for a shunt which, excited by a given number of volts, has a magnetising power of a given number of ampère turns, Mr. Andersen states :—"This forms part of the common problem : Construct a dynamo to supply C ampères at E volts, running at N revolutions per minute."

Will it be asking too much of Mr. Andersen to help me, and, in all probability, a large number of your readers, by giving us this latter formulæ, and in the same comprehensive manner as his previous ones? By doing so he will greatly oblige

Ohm.

37, Trafalgar Square, Brighton,
February 6*th*, 1886.

The Franklin Institute Tests of Dynamos.

I beg to enclose you a copy of a letter addressed to me by Prof. Marks, in deference to the request of the President and Board of Managers of the Franklin Institute, from which you will note that the Professor is rather inclined to charge me with personal motives when showing the improbability of the horse-power values obtained by the committee. I have, in justice to myself and also to prevent that the Institute may leave the impossible results on record, addressed a second letter to the Institute, of which I also enclose you a copy, and beg you to give both letters space in your valuable journal, since the discussion relates *not* to theoretical opinions, but to whether the tests made by such an eminent scientific authority are incorrect, and if so, whether or not the report ought to be annulled.

Charles F. Heinrichs.

New York, *February* 7*th*, 1886.

Competitive Tests of the Edison and Weston Dynamo-Electric Machines.

In reply to Mr. Charles F. Heinrichs' criticism of the late dynamo tests at Philadelphia, the Franklin Institute has addressed the following open letter to that gentleman :—

Franklin Institute,
Philadelphia, Pa., *Jan.* 20*th*, 1886.

Mr. Chas. F. Heinrichs, New York—

Dear Sir,—The President of the Franklin Institute hands me your letter of the 4th inst. for reply. A careful reading of its contents satisfies me that you have not grasped the method of coupling the dynamo to the dynamometer. No belt was used. Fig 7 of the report will make clear at a glance that the end of the dynamo shaft was coupled to the end of the dynamometer shaft.

The tests were competitive, and it was very necessary to eliminate the accidental variations of friction due to errors in stretching belts, in order to judge fairly of so evenly matched and highly finished machines.

There was no friction at all due to pull of belt in any case, and the brushes were always raised.

Whenever the friction of the journals was measured, it was after the machine had been running many hours.

There would be little difficulty in satisfying yourself by actual experiment upon Weston or Edison machines under similar circumstances to those of the test that the friction of the armature bearings is marvellously small.

It would be much better to do so than to take figures from antiquated machines.

Should you, for reasons of your own, desire to make out a less efficiency than that shown in the test, you should add to the power applied sufficient power to meet your views as what *might* be required by the friction due to the pull of the belt on the armature shaft, and by the bending of the belt and for the brush friction, and then this sum should be used to divide the energy of the external circuit. *The phrase "Power applied"* of the report included the friction of the shaft of the armature. Thus, if you insist that the armature friction is 1·337 H.P., you could say for

$$\text{Weston No. 7 M dynamo } \frac{26{\cdot}34}{29{\cdot}29 + 1{\cdot}337} = \text{commercial efficiency,}$$

$$\text{or } \frac{28{\cdot}47}{29{\cdot}29 + 1{\cdot}337} = \text{total efficiency of electrical conversion.}$$

A careful reading of the report, which you criticise with so much apparent confidence of a thorough knowledge of its contents, would have revealed the following paragraph on page 42 :—"The friction of the armature and of the dynamometer were obtained and *the latter* subtracted from the power applied to each test."

The committee spent much labour upon the calibration of the Tatham dynamometer, and have every confidence in its results, and believe its error from any cause to be inappreciable, as compared with others.

In deference to the request of the President and Managers of the Franklin Institute, I make reply to your letter, but do not desire to attempt further discussion, when agreement as to premises cannot be reached.

I am, faithfully yours,
Wm. D. Marks.

Competitive Tests of the Edison and Weston Dynamo-Electric Machines.

To the President and the Board of Managers of the Franklin Institute.

Gentlemen,—I have noted the contents of the letter which Prof. Marks has addressed to me in the last issue of the *Electrical World*, in deference to your instructions.

In his letter the Professor makes several substantial admissions with which I now can prove conclusively that *all* horse-power measurements made by your committee are incorrect, and have given extreme and enhanced efficiencies to all dynamos tested.

Before, however, substantiating my latter statements, permit me to state that I well know that I address in you an *impartial* scientific authority, and that you will be as much pleased if the tests under discussion can be sustained, as you will be ready to withdraw the report of tests at any time, should it be proven that the results given therein are incorrect. I further know that your committee was composed of gentlemen having great scientific attainments, and of unquestionable integrity; hence, if the tests have produced incorrect results, as I shall presently show, such incorrect results were obtained by inadvertence.

I have in my former letters compared the results obtained by your committee with those obtained by other authorities; but since I note that Prof. Marks objects to the comparisons of his tests with those made two to three years ago, for the reason that those tests were made upon "antiquated dynamos," I shall in the following explanations refer only to the tests made by your committee, and with their report and Prof. Marks's admissions, prove my above-made statements as to the incorrectness of the results.

Firstly. Prof. Marks states in his letter that the committee have every confidence in the results produced by the Tatham dynamometer; thus he maintains that *all* horse-power measurements made by the committee *are correct*. The Professor further admits *indirectly* that the measurements of the items of friction of armatures as made by your committee are incomplete and too small; because the Professor admits *directly* that the brushes were lifted during the tests of the friction of the armatures; *whilst the brushes ought to have been pressed down upon the commutator,* and so the power absorbed by the brushes would have been *duly* accounted for. Hence the phrase "friction of armature" of the report is admitted by the Professor to contain an untrue and too small value and should be taken larger, *without any special desire on my part.*

Further, Tables II., III., IV. of the report contain each two

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data of the portioned items of friction of armature obtained from the same armature on different days; but, as can be noted, the two measurements on each of the three tables differ over 50 per cent. from each other, consequently these already portioned items varying over 50 per cent. from each other, may rightly be rejected as untrue, or may be enlarged to a more probable value. I have shown in my letter of the 7th ultimo that when taking a larger and more probable value for the item of friction of armature, and calculating the electrical efficiency of the dynamo with the following well known formula:—

$$\frac{\text{Total electrical efficiency}}{(\text{Power applied}) - (\text{power absorbed by friction of armature})} = \%$$

more than 100 per cent. electrical return will be obtained. The latter result *simply proves* that the total horse-power measurements made by your committee are equally wrong. Prof. Marks replies to these calculations about as follows:—"If you *insist* that the friction of armature is larger than given by the committee, you may, instead of *deducting* it from the phrase (truly a phrase) 'power applied,' add it to the latter." How can I do that? The Professor reminds me in his letter that the phrase, power applied, means the total power indicated by the transmission dynamometer, minus the friction of the latter; thus the phrase, power applied, contains the whole value of friction of armature, including both the friction of the journals and of the brushes; and since the latter value is omitted by the committee, on calculating the true electrical efficiency of the dynamo, the true value of the friction of armature (including the power absorbed by the brushes) must be *deducted* from the "power applied," which gave over 100 per cent. electrical return. On the other hand, if I please the Professor's view of treating the data of tests, and *add* the true value of friction of armature to the "power applied" of the report, in such case the latter term becomes altogether a phrase, and the new value of the "power applied" becomes much larger than the former; thus again *proving* the incorrectness of the committee's results.

Hence the Professor will note that whenever the item of friction of armature is increased to its due value, all further calculations with the latter will prove conclusively the incorrectness of *all* horse-power measurements made by the committee.

Secondly. In his letter Prof. Marks stated that in "order to judge fairly of so evenly matched and highly finished machines no belts were used, but the dynamo was coupled directly to the transmission dynamometer," and he is satisfied that I have not "grasped" the coupling up. I beg to assure the Professor that I have indeed "grasped" and noted that such coupling will produce an enhanced commercial efficiency. The dynamos tested are to be used with a belt for the reason that no practical engines are made to run at the high speed required, and that the friction of the journals is somewhat greater with a belt than without one, notwithstanding I have not raised that point at all.

I am greatly surprised that the Professor should attempt to explain the great discrepancies, amounting up to 1,000 per cent., between the measurements made by the committee and those by other authorities, with the absence of the belt. The Professor even counts up the *bending* of the belt around the one pulley of the dynamo, yet almost with the same breath speaks confidently of the Tatham dynamometer, but forgets to mention that the large belt of the latter is *bending over six pulleys*, and that such an identical construction must be devoid of the sensitiveness required in "order to test fairly—*to the public*—such evenly matched dynamos."

I admit, gentlemen, that such arguments, though pertinent, do not prove conclusively my statements, and I will proceed to lay before you all the separate items which must be considered under the one heading of friction of armature. Although these considerations will rather increase the length of my address, still it is necessary to go into these details to show conclusively that the values of armature friction as given by your committee are altogether too small and are untrue; further, to prevent the question as to the proper value of the coefficient of friction to be a stumbling block to the final settlement of the latter question.

The friction of armature includes the following:—

I. Friction of journals can be calculated (approximately only) with the formula given in my letter of December 19th, 1885. The coefficient of journal friction is given as ·054 (average); the latter value has been deducted from a great number of experiments made by the three authorities, viz., Mr. T. Webber, U.S.A.; Mr. D. K. Clark, Great Britain; Mr. Morin, France. It will serve well for the speed and weights of the armatures tested by your committee. Prof. Thurston has shown that the theoretical coefficient of journal friction can be much smaller, but all his extremely interesting and valuable experiments were conducted under conditions in which none of the four following factors increasing the coefficient of friction were present.

II. Increase of journal friction, due to the stress of a belt, can be calculated approximately when adding to the weights of the armature and shaft the resultant stress of the belt in pounds.

III. Increase of journal friction produced by the centrifugal force resulting from a slight displacement of the centre of gyration of the armature from the centre of the shaft can be noted in most armatures, since the latter are built up from a great number of pieces of metal and insulating material, and with the surrounding conductors will never be found exactly concentric with the shaft.

IV. An increase of the coefficient of journal friction will take place by the vibrations which are always set up by the rapidly rotating armatures.

V. The resistance of the air will absorb an estimateable power since the armatures are always slightly uneven and rotate closely within the partially open field magnets at a rate of from 40 to 60 miles an hour.

VI. Power absorbed by the friction of the brushes upon the commutator is considerably larger in dynamos giving out large currents, such as tested by your committee, in which several sets of brushes are sometimes employed.

The values of none of the five first specified items can be calculated exactly; since the coefficient of journal friction *varies* with the number of revolutions and the weight of the armatures (pressure); as known, the coefficient is very great at the start, but decreases greatly with the increase of the speed up to a certain point after which the coefficient again increases rapidly, until abrasion of the journal and bearings takes place.

One test recently made by M. Marcel Deprez with a heavy armature is mentioned by Prof. Thurston,* which I shall quote, reversing the order in which it is given: "The coefficient was very great at the start and fell to ·005 at 120 revolutions per minute, and remained the same until 145 revolutions, after which it rose to ·025 at 550 revolutions;" and must evidently have increased greatly at 1,000 or more revolutions, the speeds of the dynamos tested by your committee.

All beforegoing proves that the calculations of the probable values of the power absorbed by the friction of the armature tested by your committee, as given in my letter of the 19th December, 1885, are very fair to your committee. The calculations of the friction of the journals and of the brushes were made separately, and showed that the mere journal friction calculated was much larger than given by the committee; and with the brush friction added, the total items of armature frictions were many times larger than those given by the committee: thus there can be no further doubt that the results given by the committee are altogether incorrect.

The Professor cannot further maintain that I only *insist* for reasons of my own upon a larger value of friction of armature, and I trust he will now admit that, notwithstanding the friction of the armature is "*marvellously*" *small* (when the brushes are lifted), the items given by the committee are from 300 to 1,000 per cent. too small.

Thirdly. The incorrectness of the tests made by your committee is still further proven by the following considerations relating to the transmission dynamometer used. The latter was calibrated with a load of about 40 horse-power and 700 revolutions per minute, and it was relied on for the power measurements of all other loads and speeds, which I shall show to be incorrect, and has led to the incorrect results of the measurements of the "power applied" to the dynamo.

All which has been brought forward by me when considering the variableness of the coefficient of journal friction applied to the six shafts of the Tatham dynamometer (also to the shaft and transmission pulley of every other dynamometer). The coefficient of journal friction varies greatly with the different loads and speeds, consequently the calibration of the latter of one load and speed cannot serve for another load and speed. *The dynamometer must be calibrated for every different load and speed.*

The committee have not calibrated their dynamometer for any *electrical* load and speed actually used during the tests, consequently all results must be rejected.

All the before-given explanations and considerations *prove conclusively* and *finally* that all horse-power measurements made by your committee are incorrect and must be rejected and annulled.

Summing up: you will note, Gentlemen, the following:—

1. That the horse-power measurements made by your committee of the friction of armature are admitted to be untrue, only a portion of each item was measured, and of the latter, those items which were measured twice, differ over 50 per cent. from each other. Thus the whole measurements of these items must be rejected.

2. That the values of the friction of armature given by your committee, are about from 300 to 1,000 per cent. too small, has been shown by me with all tests previously made; further, with the calculations made of this item, and the physical conditions which are pertaining to the friction of armatures. All this has proven that the already portioned values of friction of armatures as given by your committee are altogether too small.

3. That whenever one accepts the true or a probable value of the friction of armatures, and then calculates the electrical efficiency of the dynamo, the impossible result obtained proves conclusively that all horse-power measurements made by your committee are also incorrect.

4. The committee not having calibrated the dynamometer with any one of the electrical loads actually used during the tests, prevents the acceptance of any of the results obtained with that dynamometer; whatever else may be said as to the merits of the latter.

Trusting that you will, Gentlemen, now consider the advisability of withdrawal or annullment of the report of tests issued by your authority,

I beg to remain, Gentlemen,

Yours faithfully,

CHARLES F. HEINRICHS.

New York, *Feb. 2nd*, 1886.

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* "Friction and Lost Work," &c. By Prof. Thurston. New York, 1885.

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVIII.—No. 431.

JULES JAMIN.

THE Académie des Sciences, a body much less numerous than our Royal Society, has latterly sustained an exceptional series of losses in the persons of its most eminent members. Dumas, Thenard, Wurtz, Milne-Edwards, Robin—to name only those best known in this country—have passed away, leaving their places to be filled and their researches to be continued by others. The latest, and certainly not the least rogretted of these losses, is that of Jules Jamin. Called to the Perpetual Secretaryship on the death of his illustrious master, Dumas, he discharged the onerous and delicate functions of this high office to the general satisfaction of his colleagues and of the scientific world; and, though in his sixty-eighth year, his demise was no less unexpected than unwelcome.

Jules Jamin was born at Termes, in the Ardennes, May 31st, 1818. He commenced his education in a private school in the town of Vouziers. Thence he passed to the College of Rheims, gaining the highest honours, and in 1841 he left this establishment as "first agrégé" in the physical sciences. His subsequent progress was decisive. He filled with the highest credit the professorial chairs of physics at the Ecole Polytechnique, at the Sorbonne, and at the Faculté des Sciences. As a lecturer his success was remarkable. His clearness of exposition, his power of rendering even the most complicated theories clear to his hearers, will never be forgotten by his former pupils. The same attributes are displayed in his two systematic works *Traité général de physique*, which was a reproduction of his course at the Polytechnic, and his *petit Traité de physique*, where he explains the modern theories of the phenomena of light, heat, and electricity with admirable lucidity.

His researches embraced nearly all departments of physics. Perhaps to English electricians he is best known through the magnet of peculiar construction which bears his name, and his electric candle, which burns point downwards and is self-igniting. Besides his labours in optics, magnetism, and electricity, which constitute his highest claim to the notice of posterity—we remind our readers here that he was the first to complete a rational study of magneto-electric currents—his researches on the compressibility of liquids, on capillarity, hygrometry, specific heat, the critical point of gases, &c., attest the originality and the fertility of his genius. With him, as is happily said by his eulogist, M. L. Troost, teaching and discovering were identical. Nor must we forget that several of his pupils have been found ready to follow in his footsteps. Thus Blondlot has produced a valuable memoir on the "Capacity of Voltaic Polarisation," and Benoit has investigated the resistance of metals.

It may not be superfluous to remark that though a laborious and successful physicist, he was more: he was known also as a botanist and a geologist, and he found time also for metaphysics, literature, music, and the fine arts. There exist paintings from his hand not without merit. He insisted on the advantages of a closer approximation between the artist and the *savant*, united as they are by the common necessity of observing the optical appearances of natural objects. We cannot, in concluding this brief sketch of the illustrious dead, do other than express to our French fellow-labourers in the cause of science our profound sympathy for the loss they have sustained.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

X.

UNDER fairly good conditions it is possible to work a tramline, as depicted in fig. 8, with conductors by means of a stationary steam engine of 150 H.P., and this will give an average expenditure of 12·5 H.P. per car. Each car when full of passengers weighs 5 tons, and it has to run at a constant speed of 6 miles per hour. A first-rate steam engine of this power need not use more than 3·5 lbs. of good coal per H.P. hour, therefore the consumption of fuel per car mile may be taken at $\frac{12{\cdot}5 \times 3{\cdot}5}{6} = 7{\cdot}3$ lbs. nearly.

This compares very favourably with that of a tramway steam locomotive where the consumption of fuel on a similar line will amount to about 10 lbs. per mile. The tests at Antwerp showed that the consumption of coal varied between 5·4 and 9·1 lbs per car mile, but this was on a perfectly level line. To explain the reason of this large expenditure of fuel we need only consider that the dead weight of a separate locomotive engine is some 8 or 9 tons, as compared with half a ton of machinery on the electric car which carries its own motor, and we have all along assumed that this electric motor is attached to the vehicle carrying the passengers. It must also be granted that a small steam locomotive engine will consume much more fuel to produce a given power, than a large stationary engine. The loss, therefore, occasioned by the conversion and the transmission of electric energy is more than compensated for by other advantages. We do not intend to convey the idea that electric propulsion will ever compete with large locomotive engines for main lines of railways, unless some wonderfully cheap method of producing electricity is discovered; but within the limits of this discussion we can feel assured that the electric systems of propulsion are sufficiently advanced to warrant a practical success under suitable circumstances, such as for elevated lines, tramways through country districts, or along the sea shores, as, for instance, Mr. Magnus Volk's railway at Brighton, and others in places where there is no other traffic.

We cannot too strongly dwell upon the fact that one of the principal advantages with electric cars is that the motor can so readily be placed underneath the vehicle, and that by this means we utilise the weight of the same, together with the weight of the passengers, for producing the requisite adhesion between the driving wheels and rails when mounting inclines. This has been clearly pointed out by Prof. Ayrton in his interesting lecture at the London Institution some four years ago, as also on several occasions by the late Sir William Siemens. It is, therefore, surprising that at this advanced period there should be money and brain power wasted, in America as well as in England, on schemes wherein separate electric locomotives are employed for the purpose of hauling passenger cars, thus throwing aside one of the greatest virtues which electric propulsion possesses. In order

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to haul a vehicle upon ordinary rails with safety it is necessary that the hauling apparatus should weigh at least as much as the object attached to it; this law, of course, does not apply to railway trains composed of many carriages, and lines which are tolerably level, made as level as possible at any cost, but for tramway haulage it has been a long recognised fact. Whether this fact is simply ignored, or whether it is from mere ignorance we are unable to judge, but the sooner certain inventors and their supporters are made aware of it the better it will be for them and the cause they are advocating.

The space occupied by a pair of horses, or by a separate locomotive plays a part, in crowded thoroughfares, which is frequently lost sight of by the general public; but the *Railway Engineer* of February, 1883, gave some very interesting figures upon this point in an article on "Metropolitan Passenger Traffic," and we hope we are not transgressing by referring to a few of the passages. There is no mention made of electricity, but we believe the arguments are most suitable for this mode of propulsion. After some figures on the measurement of omnibuses, we read: "Bringing our thoughts now to bear on tramcars, we have also found by measurement that a tramcar and horses for 38 passengers occupy an area of 170 square feet, giving a mean ratio of 22·8 passengers per 100 square feet. But supposing the cars to be hauled by an underground cable, to which they may be fastened or unfastened by a clutch at will, so as to dispense with horses or locomotives, we have then only the area of the car itself to deal with. Those above alluded to would occupy 120 square feet of ground, giving a mean ratio of 31·6 passengers per 100 square feet of ground occupied. It is clearly shown that, as far as accommodation is concerned, tramcars, especially when the haulage power occupies no ground, have a most supreme advantage over any other street vehicle." The question of speed is also considered as important for the purpose of relieving the traffic, and there is no doubt that tramcars at present are slow and easily beaten by omnibuses. "Taking the speed of omnibuses at 8 miles per hour, trams with two horses must travel more than 7½ miles, or without horses more than 5⅓ miles per hour to be more effective." After dealing with statistics of vehicular traffic in crowded thoroughfares, the article concludes thus: "In dealing with the subject of tramways it has been our principal object to point out how they form a natural gradation between the railway train and the road vehicle.

"Tramcars are much more roomy than omnibuses and the motion is far more easy. Coming as they do halfway between trains and road vehicles, they are better adapted by their nature to combine the advantages of both. It only remains for them to increase their speed, though, of course, not without regard to safety to other vehicles. But they may, at any rate, keep pace with omnibuses, and we would emphasise the necessity of speed as much for the popularity of the tram system that would thereby be induced, as for any other consideration.

"To make them popular is most important, as it is plain that their economy of ground space can be of no avail if the public are not attracted into their use. Economy of ground space they have, and comfort, and *speed* is what is next required to render them the most effectual means of relieving street passenger traffic that is in existence. Properly developed and brought to a state nearer perfection, there can be no doubt that tramways, like railways, must materially tend to the general advancement of our great towns."

We need not point out that electricity, especially when the energy can be carried within the vehicle, is destined to play a most important part in the development of tramways. Electricity is decidedly cheaper than horseflesh, and it has none of the drawbacks which are to be found in steam or any other means of mechanical traction. It is a question of deciding upon one system or another in every case; for short suburban lines, as already stated, conductors may be found suitable; but for populous streets and districts the insulated conductor involves difficulties, and the more advantageous under these circumstances will be the system in which secondary batteries are employed where the store of energy is carried in the car under the seats. There are certain objections to be disposed of in connection with the utilisation of secondary batteries, and we propose to deal with these objections *seriatim*. One of the most popular objections is the weight of these batteries; and it has been often predicted that this is so serious that it is folly to occupy oneself with this idea of transmitting electric energy. Men of reputation in the scientific world have endeavoured to prove by calculations that nothing can ever come of such a scheme, not merely on account of the great weight but also on account of the losses which take place in the process of storing electric energy and the several processes involved in the conversion. The discouraging figures as regards the weight were based on the assumption that secondary batteries attained their highest grade of capacity several years ago, when they were first introduced. No account was taken of the fact that the enormous energy of 360,000 foot pounds was contained in one pound weight of oxidised lead, and that there was a great margin left for improvement. It is doubtful whether much further progress can be made in the lead accumulator of the present day without sacrificing durability; but secondary batteries have been, and are being successfully applied, for the purposes of electric locomotion, whose weight are by no means prohibitory. Thus, a tramcar furnished with accumulators will only weigh one-fifth more than a car without these adjuncts, or, in other words, the total weight has not to be increased by more than 20 per cent. This is trifling when compared with steam, compressed air, cable or other modes of mechanical haulage. It is not our intention to make comparisons between these different methods of propelling tramcars, but we propose merely to study the points of economy and general efficiency of the electrical systems, and draw comparisons between these and the most popular tramcar motor, the horse.

ELECTRO-MAGNETS IN COMPOUND MACHINES.

In the so-called compound dynamos, named also, according to a recent suggestion, compensation machines, the iron core receives, as is well known, writes Wilhelm Peukert in *Zeitschrift für Electrotechnik*, two wrappings. The one with the thicker wire is introduced into the main circuit, whilst the other of thinner wire forms either a by-circuit of the armature or of the outer circuit. In such machines, consequently, the iron cores are magnetically excited by two magnetising forces, and the question as to the total magnetism resulting under such circumstances has therefore acquired an especial practical importance.

Dr. O. Frölich gives, in one of his most recent treatises (*Elektrotechn. Anzeiger*, 1885, No. 15), a formula which allows of the calculation of the magnetism resulting from two given magnetising components. If, with him, we call the degrees of magnetic saturation produced by the two windings (each supposed to act singly), M_1 and M_2, Frölich's formula

$$1 - M = \frac{(1 - M_1)(1 - M_2)}{1 - M_1 M_2} \qquad (1.)$$

is applicable for the magnetism resulting from the simultaneous action of both windings. This relation follows naturally from the relation given by Frölich between the magnetism, M, and the strength of the current, J, that is from the equation

$$M = \frac{m J}{1 + m J},$$

in which m is a value depending on the windings of the limbs.

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Dr. Frölich, when stating this formula (1), gives no results which might serve as an experimental confirmation. I had recently the opportunity of carrying out some experiments with this purpose in order to determine experimentally the total magnetism produced in an iron core by two magnetising forces acting simultaneously, both in the case when the two magnetic components support each other, and when they act in mutual opposition. I may here premise that the results obtained fully agree with Frölich's formula.

The experiments were conducted with a magnet limb of a compound machine which had been most obligingly placed at the disposal of the Electrotechnical Institution by the firm Kremenezky and Mayer, of Vienna.

The electro-magnet, the cylindrical iron core of which had a diameter of 10 centimetres and a length of 35·6 centimetres, had two windings. The inner one had with 45 double turns of a wire 3·64 millimetres in thickness (measured with its double coating) 6 layers, each of 90 turns, or, in all, 540 turns. The outer one consisted of 14 layers, each of 200 turns of a wire 1·66 millimetres in thickness. The degrees of magnetic saturation attained are represented by the quotients of the temporary magnetic moments actually obtained for the different strengths of the current and the maximum moment of the iron core. For calculating the latter the absolute unit of Waltenhofen were assumed to be 212·5 per unit of weight (Gramme), so that the resulting value was 4633·000.

The determination of the temporary moments in absolute measurement was effected by deflection experiments in which the electro-magnet was placed opposite to a short declination-needle in the so-called first main position. In the more feeble magnetic moments the electro-magnet acted upon a magnetic needle, 1·8 centimetre in length, whose axis of rotation was at a distance of 144·8 centimetres from the middle of the iron core. In experiments with stronger moments the deflections were read off on a needle 2·5 centimetres in length, placed at a distance of 299·3 centimetres from the middle of the electro-magnet. Both needles were provided with aluminium pointers, which moved over corresponding graduated scales. On account of the distances off of the needles being considerable as compared with their length a correction on account of length was superfluous in calculating the results. The magnetic moments of the coils were calculated from the total surfaces of all the turns (for which the values 63·583 and 616·470 were found) by multiplying by the strength of the current in absolute units, and deducting the result from the total moment. If we call this M, and the moment of the spirals m, we have for the moment of the iron core $M_0 = M - m$, for which, if we express M and m in the ordinary manner, we may write:

$$M_0 = \frac{a\,3\,H}{2} \,.\, \tan.\,\alpha - J\,\Sigma\,F\,.$$

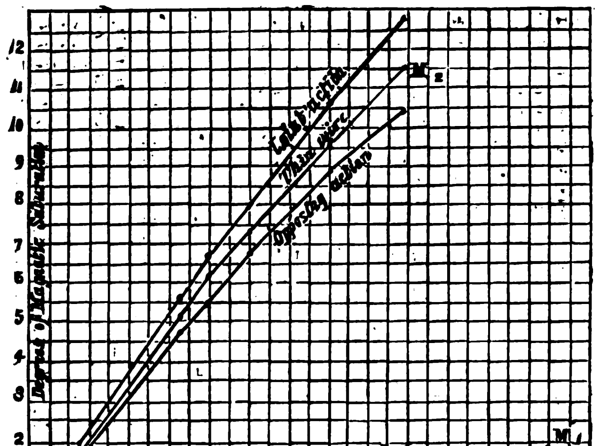
Here a is the distance of the needle from the middle of the iron core, H the horizontal intensity of terrestrial magnetism, and α the angle of deflection of the needle.

If we call the maximum moment M, the proportion $\frac{M_0}{M}$ gives the degree of saturation obtained.

The current was furnished by a Schuckert's compound dynamo, which could be brought up to the yield required, on every occasion, by rheostats introduced into the circuit, a sufficient selection of which was at hand. The strength of the current was measured by means of a Gaugain tangent galvanometer made by Siemens and Halske with the use of the ring, for which I determined the factor of reduction by means of a copper voltameter as 4·20. The readings on the galvanometer were undertaken by the assistant K. Zickler, to whom I express my best thanks. For each strength of the current at least six readings were taken (varying the direction of the current), and the mean values thus obtained were used as the basis of the further calculations. The results are given in the following table.

Number.	Strength of current in ampères.	Magnetic moments.		Degrees of saturation.		Joint action.			Opposed action.		
						Moments.	Degrees of saturation.		Moments.	Degrees of saturation.	
		Thick wire.	Thin wire.	M_1	M_2		Determined by experiment.	Calculated.		Determined by experiment.	Calculated.
1	0·436	17·620	168·864	0·0038	0·0364	189·522	0·0409	0·0399	151·530	0·0329	0·0328
2	1·243	51·886	477·534	0·0112	0·1031	527·945	0·1139	0·1127	436·673	0·0943	0·0935
3	1·492	63·626	584·512	0·0137	0·1262	625·393	0·1349	0·1366	518·654	0·1119	0·1157
4	1·817	74·200	691·991	0·0160	0·1494	751·996	0·1623	0·1611	629·671	0·1358	0·1377
5	2·498	104·152	890·122	0·0225	0·1921	985·324	0·2127	0·2069	827·871	0·1786	0·1775
6	3·133	129·186	1067·395	0·0281	0·2304	1179·994	0·2547	0·2471	970·096	0·2093	0·2139
7	3·768	154·442	......	0·0333							
8	4·349	177·623	......	0·0383							

The degrees of saturation given in the table as calculated, have been worked out according to Frölich's formula, as given above, and agree very well with the experimental results. When using the thin wire a current strength of three ampères could not be exceeded on account of the considerable heating of the wire. Hence the experiments 7 and 8 with this combination were omitted.



The accompanying diagram shows the connection between the strength of the current and the degrees of saturation reached. The strengths of the current are plotted out on the abscissal axis, and the degrees of saturation as ordinates. The curves thus obtained display, even at these degrees of saturation, a concavity towards the abscissal axis, a noteworthy fact, since according to this relation the proportionality of the degree of saturation to the strength of the current in thick rods is confined within much narrower limits

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than is universally assumed, since according to the electro-magnetic researches of Dr. A. von Waltenhofen, conducted with thinner rods, the proportionality has been found to extend up to degrees of saturation of 40 to 50 per cent.

The magnetic moments laid down in the table induce me to mention a formula for their calculation from the dimensions of the rods, which Dr. A. von Waltenhofen has given in his latest memoir (*Zeitschrift für Elektrotechnik*, 1886, p. 2). If we call the respective length and thickness of the iron core in centimetres l and d, the total number of turns of the winding, n, and the strength of the magnetising current, i, then according to Waltenhofen's formula the magnetic moment reached is

$$y = 0{\cdot}09\, l^{1\cdot6} \,.\, d^{0\cdot7} \,.\, n\, i$$

Dr. A. von Waltenhofen mentions in the same place experiments which verify the formula within very extended limits. As a further confirmation of the formula may serve, the following table in which the values calculated according to the formula are placed in juxtaposition with those observed.

MAGNETIC MOMENTS.

Observed,	Calculated.	Observed.	Calculated.
17·620	16·270	168·864	168·723
51·886	45·925	477·534	476·641
63·626	55·169	584·512	572·123
74·200	67·150	691·991	696·747
104·152	92·367	890·122	957·884
129·186	115·810	1067·395	1201·380
154·442	139·327		
177·633	160·774		

Within the limits of proportionality (for which the formula is only applicable) the observed and the calculated values agree very well, especially those produced by the thin wire, since here there are only discrepancies of two per cent. For the thick wire there certainly occur more considerable differences which, however, extend to 13 per cent. in one case only, and which are probably due not to the formula but to the circumstance that between the double turns of this wrapping there existed certain inequalities which could not be taken into account in the calculation. But even if these differences do not depend on the circumstance mentioned but on the formula, it still remains very valuable, the more, if we consider that hitherto we were not in a position to carry out such calculations even approximately and within wide limits.

Finally, I must claim permission to express my gratitude to Dr. A. von Waltenhofen, President of the Electro-technical Institute, who has courteously afforded me the facilities for carrying out these researches.

PNEUMATIC TELEGRAPH TUBES.

IN a recent number of the ELECTRICAL REVIEW I noticed that some enterprising gentleman had devised a system of pneumatic tubes, combined with electric appliances, by which telegrams, letters, &c., could be transported. Since but little has been published upon postal or telegraphic pneumatic transmission, I trust that the following brief description of the pneumatic telegraph tubes used in this country may not prove without interest.

The pneumatic tubes used in Great Britain are made of lead, and when laid beneath the streets they are enclosed in iron pipes for protection. The tubes vary in length from two miles downwards, the average length being about ¾ mile. The diameter of the longer and more important tubes is 3 inches, and that of the shorter and less important tubes 2¼ inches. The carriers within which the messages are sent through the tubes are made of gutta percha tubing, covered with felt, and have a head of several pieces of felt which accurately fits the tube. The carriers used with the 3 inch tubes weigh about 7 ozs., and will contain about 36 messages; those used with the 2¼ inch tubes weigh about 2¾ ozs., and will contain about 12 messages.

Each of the tubes is provided with a simple electrical contrivance by which the departure from and the arrival at each station of the carriers is signalled.

The power by which these tubes are worked is derived from steam engines located at the central office. These engines work air pumps which either take air from the atmosphere and compress it to a smaller volume and then discharge it into the pressure main, whence it is admitted by means of taps into the different tubes when carriers are despatched to an out-station; or the pumps take air from the vacuum main, compress it to the atmospheric pressure and then discharge it into the atmosphere; the air in the vacuum main is, of course, being continually renewed by the air which flows from the atmosphere through the tubes into the vacuum mains during the transit of the carriers from the out-stations.

The velocity with which the carriers travel is usually between ⅓ and ½ a mile per minute. The approximate time of transit in minutes through a tube of L miles $= 2{\cdot}7\,L^{\frac{3}{2}}$ with the 2¼ inch tube, and $2{\cdot}1\,L^{\frac{3}{2}}$ with the 3 inch tube.

The energy expended in driving a carrier from the central office to an out-station is equal to the volume of compressed air which flows into the tube during the transit multiplied by the work required to produce a unit volume of compressed air.

The volume of compressed air which flows into the tube during transit is equal to about 6/7 of the tube's cubical capacity. The capacities of the 2¼ and 3 inch tubes are 146 and 251 cubic feet per mile respectively, so that the volumes of compressed air used in driving a carrier through a mile of each tube are 125 and 200 cubic feet respectively.

The work required to produce a cubic foot of compressed air at a pressure p_1 from a pressure p_0, lies between the isothermal value

$$\cdot01005\, p_1 \log. \frac{p_1}{p_0} \text{ horse-power minutes.} \qquad (1)$$

and the adiabatical value

$$\cdot01505\, p_1 \left\{ \left(\frac{p_1}{p_0}\right)^{\cdot29} - 1 \right\} \text{ horse-power minutes.} \qquad (2)$$

So that to produce a cubic foot of compressed air at a pressure of 12 pounds to the square inch above the atmospheric pressure would require between ·0695 and ·0755 nett horse-power minutes, or say about ·085 gross horse-power minutes; and, therefore, the energy expended in driving a carrier through a mile of the 2¼ and 3 inch tubes would be 10·6 and 17 horse-power minutes respectively.

When a carrier is despatched from an out-station to the central office, the air in the tube first expands into the vacuum main and thence into the pumps, where it is compressed to the atmospheric pressure and then discharged into the atmosphere. By the aid of formulæ (1) and (2) it is found that the gross amount of work of ·065 horse-power minutes is required to pump a cubic foot of air into the atmosphere from a vacuum main at a pressure of 8 pounds per square inch below the atmospheric pressure. If the tube has been at rest immediately before the carrier is despatched to the central office, the volume of air which will be pumped into the atmosphere from the vacuum mains will be equal to the cubical capacity of the tube; and therefore the energy expended in the transmission of the carrier would be 8 and 13 horse-power minutes with the 2¼ and 3 inch tubes respectively. If, however, the tube had immediately previously been used to receive a carrier from an out-station, there would be a partial vacuum in the tube, and therefore the expenditure of energy would be less, say 6½ and 10½ horse-power minutes respectively. But if, on the other hand, the

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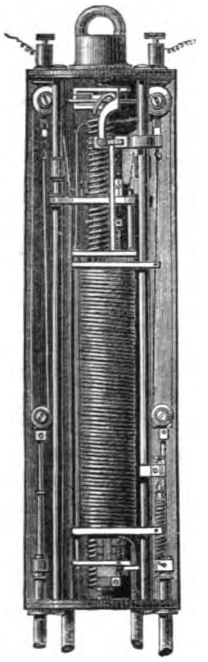
tube had just previously been used to despatch a carrier to an out-station, it would be partially filled with compressed air; and the amount of work which the pumps would have to perform would be greater, and the amount of energy expended during the transit of the carrier would be about 12 and 19 horse-power minutes with the $2\frac{1}{4}$ and 3 inch tubes respectively.

These amounts of energy would be expended in several different forms. Firstly, work would be performed in pushing back the atmosphere at that end of the tube at which the pressure was lowest; secondly, energy would be expended in generating mechanical vibrations of the tube; and, thirdly, in overcoming the friction of the carrier within the tube. The first of these quantities is much the greatest, and is equal to about $\frac{3}{4}$ the net work of the engine in pressure working, or about $\frac{2}{3}$ the net work of the engine in vacuum working.



The energy expended in overcoming the friction of the carrier may be approximately calculated from the formula

$$\frac{W\ L}{150} \text{ horse-power minutes,}$$

where W is the weight of the carrier in ounces and L length of tube in miles.

Thus, with the $2\frac{1}{4}$ inch tube, the energy expended in overcoming the friction of the carrier through a mile of tube would be about $\frac{1}{50}$ horse-power minute, or with the 3 inch tube about $\frac{1}{20}$ horse-power minute. So that the energy expended in overcoming the friction of the carrier itself would be only $\frac{1}{200}$ to $\frac{1}{500}$ of that expended in expelling the air from the tube.

The expenditure of energy in the transport of a pneumatic carrier is enormous as compared with other methods of transportation. Thus with the same expenditure of energy a locomotive will transport as many tons upon a railway as a pneumatic tube will transport ounces. The use of pneumatic tubes for transport purposes is indeed so wasteful of energy that it has completely failed to be practicable, except in pneumatic telegraph transmission; and it is possible that even for telegraphic purposes pneumatic tubes may be ultimately superseded by some more economical system.

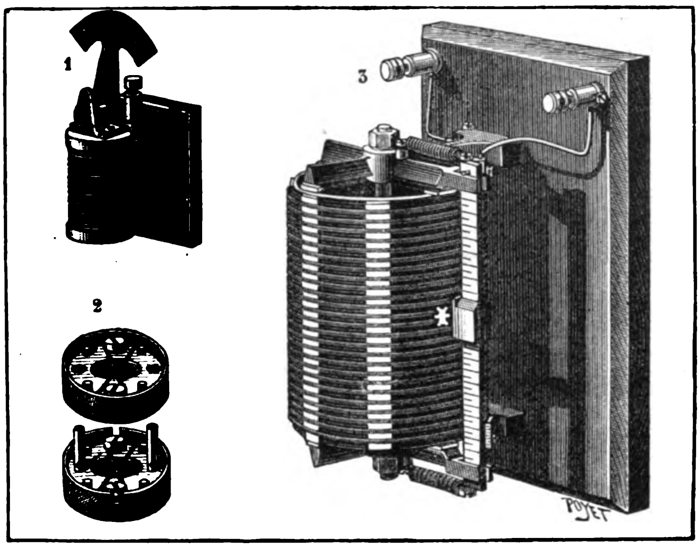
W. MOON.

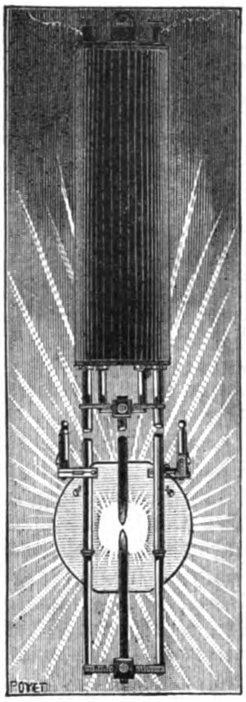
The "Palace of Delight."—The Governors of the Salt Schools, Saltaire, have resolved, in consequence of the delay in the building operations caused by the prolonged frost, to defer the opening of the Palace of Delight until May 3rd, 1887.

THE LIGHTING OF THE ELDORADO.

AMONGST the recent installations in Paris one of the most noteworthy is certainly that of the Eldorado Café and Theatre. The results obtained, the steadiness of the light, and its uniform distribution, even on the stage, and all the advantages of the electric light—absence of heat and smell, the preservation of the decorations, &c.—prove once more, states a writer in *La Nature*, that electric lighting is eminently practical and that the electric light really is the light of the future.

For reasons into which we need not enter here, the installation has been made without any reserve apparatus, therefore an accident, or mischance, happening to any part whatever of this installation would necessarily cause a complete stoppage; it is, therefore, most risky to light a theatre under such conditions,





but up to the present the experiment has been crowned with success.

The steam is supplied by a Collet tubular boiler; the steam engine, which is horizontal, with a single cylinder, was constructed by Messrs. Orly and Grand-demange. It actuates two groups of Gramme machines (workshop type) excited in derivation and constructed by the firm of Ducommun.

Each machine feeds five Cancé lamps grouped in parallel at the terminals of the dynamo, *i.e.*, each of them has its distinct circuit. This is evidently not an economical method, or one applicable to large areas, but it ensures the absolute independence of each group, which, in the particular case of a public building, and especially a theatre, is of primary importance, for the working of each lamp can be regulated from the engine room. To effect this, on the circuit of each is placed a regulating apparatus, which protects it against any abnormal excess of current. Each lamp is furnished with a fusible leaden wire, which serves to break the circuit and which has this advantage, that, when one of these wires is melted it can be replaced by another, so that the extinction lasts but a very short time.

The breaking of this wire ought only to take place in a case impossible to avoid, for a current indicator gives with sufficient exactness at every moment the intensity of each lamp, which value can be corrected by the aid of a metallic rheostat of German silver wire, the resistance of which can be altered without interrupting the current.

A special arrangement of double commutator for two directions has been added to enable a single spare machine to be substituted, at will, for any one of the dynamos of the installation, in case any interruption

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should occur during the working; it is thus possible to provide against accident to any one of the electrical machines.

The most original and remarkable feature in this installation is certainly the lighting of the footlights. Rejecting the methods adopted and applied up to that time, *i.e.*, instead of having a large number of lights of low intensity, M. Cancé has employed arc lights; in this particular case they are six in number, three on each side. It was indispensable to arrange them so that the distribution of the light should be uniform, and to avoid shadows being cast upon the stage, which would have been highly objectionable. In order to effect this the lights are enclosed in a rectangular box, the sides of which, being painted white, reflect the luminous rays in all directions, and give them out in the form of a sheaf with a vertical axis. By the aid of reflectors the rays which by these reflections would be directed into the hall are concentrated upon the stage; and, in order that the lights may not be so dazzling as to incommode the actors, the rays pass through opal globes. In order to obtain stage effects, masses of colour, twilight or comparative darkness, a series of curtains of different colours and thicknesses can be drawn before the glass, and so produce either suddenly or gradually the effect required. When complete darkness is required the stage lights and footlights are extinguished, but an equivalent resistance is substituted for them so as not to affect the working of the machinery.

M. Cancé has contrived a special rheostat in which the resistance consists of a liquid mass to which the current is conveyed by a series of metallic plates which are entirely immersed. By causing the surfaces directly opposite one another to vary, the liquid resistance interposed between the two series of electrodes is changed.

This apparatus has the advantage of being very easily regulated continuously, and there is also less fear of its getting heated than with the metallic spirals of the ordinary rheostats. Having described all the details of the working of the apparatus, we will conclude by giving a description of the lamp employed in this installation. It has a fixed luminous point and is mounted in derivation, consequently the regulating solenoids are in the circuit. The two carbons are held by two cross bars united by cords, running in such a manner on the return pulleys that the lower (negative) carbon is shifted at half the rate of the upper carbon, which is positive. The regulation is effected by acting on the upper carbon holder; it is connected with a screw nut which passes into a screw movable only round its axis. A brake actuated by the solenoids works upon the screw. If the pressure is strong enough to hinder it from turning the screw remains fixed and the carbons keep the same distance apart; if the solenoids act with less force, *i.e.*, if the arc increases beyond a certain limit the brake acts, the screw turns and the carbons are brought nearer together, and thus the arc is restored to its normal length. The regulation acts surely and without jerks; the working is thus regular, and consequently the light is steady and without any appreciable variation as long as the current which feeds it remains constant.

The regular working, the quality of the light, and, above all, the ingenious contrivances designed and applied by M. Cancé render this installation of the electric light, the mechanical importance of which is comparatively slight, certainly one of the most remarkable in Paris.

The Light at Hell Gate.—Pilots have grumbled a great deal of late, says the *Electrical World* of the 6th inst., when going through Hell Gate after dark. For the last twelve days that neighbourhood has been shrouded with general gloom, no electric light illuminating its tortuous channels, the engines and boilers being shut down for repairs. The light will shine forth again in a week or two.

THE PRODUCTION OF ALUMINUM AND ITS ALLOYS IN THE ELECTRIC FURNACE.*

By EUGENE H. COWLES.

In order that I may give you as brief and explicit an explanation as possible of our discovery, process and inventions, I will first proceed with a description of the plant of the Cowles Electric Smelting and Aluminum Company, now in operation at the works of the Brush Electric Company, at Cleveland, O.

The apparatus used by us for the purpose of experiment in the reduction of refractory ores for the production of metallic calcium, magnesium, potassium, sodium, silicon, titanium, and the manufacture of aluminum and aluminum-bronze and other alloys consists of two large Brush dynamos, two resistance boxes and two ammeters, a drying pan, eight fire-brick furnaces, suitable electrical conductors and switches, hoods for carrying off vapour and gases, large carbons—3 by 30 inches—for electrodes, screens for sizing charcoal and carbon, and a large mortar and pestle and several washing vats for washing and concentrating the furnace products. Steam power to drive the dynamos is furnished by the Brush Electric Company. The arrangement of the plant so as to effect the reduction of the above-named metals and metaloids, by means of carbon as the sole re-agent, is as follows:

The Dynamos.—These are, of course, placed in the dynamo room as near as possible to the driving shaft, where they can be kept free from any dust or grit from the furnace room. The larger of these is by far the most powerful machine ever built by the Brush Electric Company. It weighs over 7,000 pounds, and at a speed of 907 revolutions per minute produces a current of 1,575 ampères with an intensity of 46·7 volts. It is of the shunt-wound shape of dynamo, built for the purpose of incandescent lighting; further than being of greater capacity, and having a hub made of the Cowles aluminum-brass which exhibited a tensile strength of 95,000 pounds per square inch and 5 per cent. elongation, this dynamo does not differ from the ordinary machine.

Conduction of the Current of the Large Dynamo to the furnace in the furnace room and back to the machine, is accomplished by a complete metallic circuit except where it is broken by the interposition of carbon electrodes, and the mass of pulverised carbon in which the decomposition of the ore takes place. This circuit consists of thirteen copper wires each 0·3 inches in diameter. There is likewise inserted into this circuit an ampèremeter through whose helix the entire current flows, indicating, by its suction of a plunger armature attached to a spring balance and dial-faced indicator, the total strength of current being used.

This ampèremeter is an important element in the management of the furnace, as by the position of the finger on the dial the furnace attendant can tell to a nicety what is being done by the current within the furnace. It is placed upon a shelf in a good light, near to and in full view of a person in any position about the furnace.

Between the ammeter and the furnace in the furnace room, and forming part of the circuit, is placed a large resistance coil of German silver immersed in water, a heavy copper slide passing backward or forwards as desired, throwing more or less of this resistance into the circuit, and almost the entire energy of the current may be thus applied to heating water. The object of the resistance box is to serve as a safety appliance. It is used by the furnace operator when it is desired to change the current from one furnace to another, or if it be necessary to choke off the current almost entirely before breaking it by a switch, thus preventing serious flashing at the commutator of the dynamo or at the switch. It is likewise of value should any evidence of a short circuit appear in the furnace or elsewhere.

Thus far the apparatus that has been described, presents no novel feature beyond its great magnitude, the peculiar combination made, and the purpose for which it is used. Now, however, we will describe a device that we claim is something radically different from anything that has heretofore been known, namely an incandescent electrical furnace for the smelting of refractory ores, metals and compounds, and in which other metallurgical and chemical operations, impossible in the past, may now be performed with both ease and economy. This furnace as constructed to utilise the current of the large dynamo, is a rectangular oblong box of fire-brick, with walls, bottom and ends, 9 inches thick. The interior space being 5 feet long by 1 foot wide and 1 foot deep. This is closed by a cast iron slab or cover through which are two 3-inch holes for the escape of the gases liberated during the operation. This lid may be removed at will, its own weight being all that is required to keep it in place. The walls of the furnace are designed to be air-tight. At both ends of the furnace are holes large enough to admit an enormous electric light carbon, 3 inches in diameter and 30 inches long. Each of these carbons is connected at the end, projecting outside of the furnace, with the positive or negative conductor as the case may be, the connection being a copper cap fitting over the end of the electrode, the same being fastened to a large and flexible wire cable which forms part of the circuit. When it is desired to charge the furnace, it is first necessary to lime it, to prevent its destruction by heat. To do this, a quantity of finely pulverised charcoal that has been soaked in a solution of lime and water, and then thoroughly dried in the drying pan, is put into the fire-brick

* Read at a meeting of the Franklin Institute, January 20th, 1886.

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box, enough being placed therein to cover the floor to a depth of several inches. The carbon electrodes are then pushed into the box through the end walls until the ends of the carbons are but a few inches apart. These electrodes are just on top of the finely powdered charcoal of the floor. A sheet iron gauge or guard, parallelogram shaped, and open at top and bottom, is now placed over these electrodes in such a manner as to form two walls on either side of the electrodes about three inches distant. Space is thus left between the sheet iron and the walls of the furnace, and likewise for about a foot at each end of the same. More finely powdered limed charcoal is put into the furnace box so as to completely fill the space outside the sheet iron gauge and within the furnace walls and up to within a couple of inches of the top. The furnace is now almost entirely full of the lime washed charcoal, except the space 9 inches wide, 3 feet long and 6 inches deep in the centre of the box, and into which the electrodes project. All is now ready for the charge, which is prepared. Should it be desired to produce aluminum bronze, we mix 16 or 18 pounds of granulated copper, 12 to 14 pounds of aluminum oxide in the form of broken corundum, and several pounds of coarsely broken charcoal together, and burying the electrodes with the same, and thus filling the space inside the walls of the sheet iron gauge. The gauge is then lifted from the furnace, additional coarse charcoal is spread over the entire mass, the iron top of box is put in place, the seams luted with fire clay, the current from the dynamo switched on, and the furnace is in operation in but little more time than it has taken to give these apparently trifling but very important details.

We will now proceed to make a little study of the philosophy of the process, after first watching a successful "run" or "heat" from the beginning to the close of the operation. Of course, the furnace and its contents, when the current of electricity was turned on, were entirely cold and the resistance presented to the flow of the current consequently is higher than it would be at any time during the "heat," unless some unforeseen accident, such as a slight explosion of gas, takes place. But notwithstanding that the furnace is cold, a complete metallic circuit, with carbon tips dangerously near together, is ready to convey a 100 horse-power flash of lightning into the furnace, should a short circuit occur. *There are likewise many pounds of pure copper in between and about these carbon tips that may be melted and run together and thus produce a short circuit. With these conditions an electrician would insist that the man in charge of the furnace should look pretty sharply lest the four thousand dollar dynamo at the other end of the wire be burned out, or somebody be injured by a heavy flash.* The man in charge, however, has anticipated such a contingency by having thrown in several coils of the resistance box, so that under no condition, even if the great carbons in the furnace were pressed tight together, would the dynamo be able to produce a current of more than 1,600 ampères, the maximum load. Upon watching the ampèremeter, however, it is seen that this precaution was not necessary for only about 200 ampères are indicated as flowing, the artificial resistance is therefore slightly diminished, the needle of the ammeter moves up rapidly to 600 or 800 ampères, suddenly it gives a jump up to 1,200, then back to 200, then with a bang the armature of the ammeter is brought against the magnet and it registers 1,600 ampères of current flowing, and then instantly drops back to almost zero.

As every jump of that needle means wear and tear on the commutator and brushes of the dynamo, care is now taken to keep more control of the current and a little more artificial resistance is thrown into the circuit. The needle now moves more slowly around the dial, gradually making fewer and fewer jumps, and at the end of eight or ten minutes it has worked up to the 1,000 ampère mark, and becomes quite steady. Suddenly there is a hiss and a sharp report, a tongue of greenish yellow copper flame darts upwards from the hole in the furnace top and then disappears, to be followed after a minute or so by a slight vapour. This was caused by the monoxide of carbon combining with the atmosphere in the furnace to produce an explosive compound. To prevent this gas from accumulating to an extent to raise the furnace top and loosen the luting, the attendant holds a lighted stick over the vent and a series of slight explosions follow.

Soon a characteristic yellow-white flame appears above the hole, the needle registers about 1,200 ampères of current flowing, all of the artificial resistance is withdrawn, and the process of reducing aluminum and alloying it directly with copper is completely under way. Soon the needle gradually creeps around the dial to the 1,400 or 1,500 ampère mark. This is regarded as being a little too hot work for the dynamo, and at the same time the plume of flame above the furnace indicates a little less rapid reduction. There are, therefore, two things now necessary. The first is to put more resistance into the circuit, and the second is to put more ore into the zone of reduction. These are both done by withdrawing one of the electrodes and the ammeter needle drops back to 1,200, and the flame above the furnace soon gives evidence of doing more work, by reason of more copious white fumes being given off.

This pulling out of the electrodes is repeated over and over again until both are out to their full length. At the end of an hour the "heat" is completed. The current is then switched to another furnace, but one furnace being used at a heat. The artificial resistance is again resorted to, enough being thrown into the circuit gradually, thus slowly choking off the current, permitting the proper regulation of the brushes on the dynamo, and also giving time for the engine to govern itself. Finally, at the end of several minutes, the switch is thrown open and the furnace is entirely out of the circuit. Furnace No. 2 is now operated in precisely the same manner as the furnace No. 1, which is allowed to cool off. At the end of two hours furnace No. 2 is thrown out of the circuit and work begun on furnace No. 3. By this time No. 1 is ready to be discharged. The lid is removed, and water is used with a sprinkling pot to quench the fire still remaining. At the bottom of the furnace, on the floor of fine charcoal, is found an oblong metallic and crystalline mass of white metal. It is the copper charged with from 15 to 35 per cent. of aluminum and a small quantity of silicon. It frequently averages 20 per cent. to 22 per cent. of aluminum and silicon. Covering this mass is also found a considerable quantity of fused carbide of aluminum. Analysis of this product has shown 30 to 60 per cent, of metallic aluminum present. On cooling, it forms very large and distinct crystals.

The very rich white bronze is collected together, put into an ordinary graphite crucible, and run into ingots weiging 50 or 60 pounds. These are carefully analysed by the chemist, after which they are remelted and copper is added to them in the proper proportion to reduce them to the standard 10 per cent. aluminum bronze. To guard against mistakes being made in the analysis of the white and brittle ingots in the amount of copper added thereto, and in keeping the bronze free from impurity, every ingot of 10 per cent. aluminum bronze has its tensile strength tested, and it must show a tenacity of at least 90,000 pounds to the square inch.

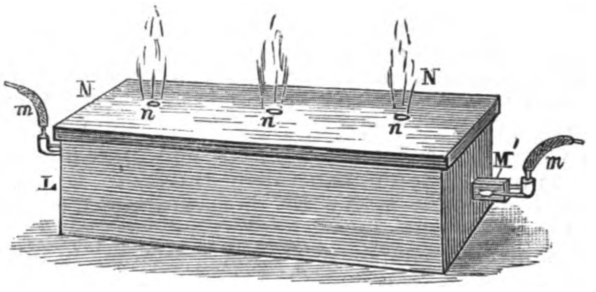

FIG. 1.

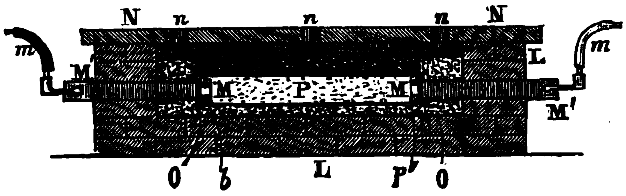

FIG. 2.

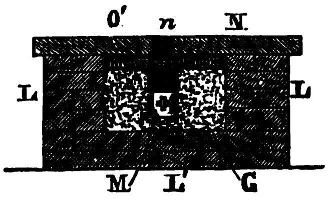

FIG. 3.

L L'. Fire-brick floor and walls. N. Removable fire-clay cover. n. Vents for escaping gases. M M'. Electrodes. m. Conducting wires to dynamos. O. Packing of fine charcoal. P. Charge of ore and granular charcoal. O'. Layer of granular charcoal, covering charge on top.

As to the capacity of our large dynamo, and the economy of the process, a few figures may be interesting. In ordinary circumstances we expect to average a daily production of at least 300 pounds of 10 per cent. aluminum bronze for 20 hours' work with each machine of this size. In addition to this 300 pounds of bronze, containing in round numbers 30 pounds of aluminum, there is produced about 60 pounds of metallic aluminum in the bye-products, a large portion of which, with proper concentrating apparatus, will be cheaply reclaimed and rendered marketable. Ninety pounds of aluminum in 20 hours is a production of four and one-half pounds per hour. Four and one-half pounds per hour produced by the energy of 120 horse-power equals the consumption of about 26·6 horse-power per hour to reduce one pound of aluminum. At times we have far exceeded this result. Indeed, two heats have been made wherein the energy consumed has been but twelve and one-half horse-power per hour per pound of metallic aluminum produced. Theoretically it should consume only about four and one-half horse-power per hour to effect the reduction, and in a new form of compound furnace to be built at our Lockport works, and in which 1,000 horse-power will be consumed, it is confidently expected that the output of bronze will not consume more than 15 to 20 horse-power per hour for the reduction of one pound of aluminum.

Economy of the Process.—This may best be judged by the public in a general way from the fact that we are selling our 10 per cent. aluminum bronze as low in some instances as 45 cents per pound net, and we are not selling it at a loss financially. This same bronze cannot be purchased elsewhere for less than $1.30 per pound. Our list price on 10 per cent. bronze is 60 cents per pound.

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The two and one-half per cent, five per cent. and seven and one-half per cent. bronzes are all proportionately less in cost. By the addition of zinc to the lower grades of aluminum bronze an aluminum brass is produced which is at once tough and malleable and of at least three times the tensile strength of ordinary brass. This brass has also vastly superior power to resist corrosion and oxidization. It can be made from the aluminum bronze at a total cost of 18 or 20 cents per pound.

Value of Electric Smelting.—The Cowles Electric Smelting and Aluminum Company claims that its process of electric smelting, within the next five or ten years, is destined to as completely revolutionise the brass and bronze trade of the world as the Bessemer converter has the iron and steel industry. This claim is based simply upon the ease and cheapness by which it can produce the alloys of aluminum and silicon, and the vast superiority of these alloys over any composition now in the market. It is further believed that cheap aluminum bronze means a new era in warfare; that it insures a return to the age of bronze in the matter of heavy cannon, armour plates, gun carriages and small firearms. Why aluminum bronze is the best metal for heavy guns is because sound, reliable and malleable castings can be made of at least 50 tons tensile strength per square inch, an endurance that far exceeds that of any forged iron or steel when made into heavy guns, and a finished gun of this kind can probably be manufactured in one-quarter of the time and at far less cost of one made of steel. Heavy pieces of steel ordnance now cost from 75 cents to $1 per pound, require a vast plant for their production and a very long time for completion. The same guns made from aluminum bronze could be cast in an ordinary foundry of sufficient capacity and finished in a lathe, thus avoiding all forging, welding, shrinking on of rings, tempering, drilling, and annealing now required in the manipulation of heavy steel and iron cannons. Armour plates for heavy fortifications and ships could be made completely from cast metal, no machine work being required to finish them ready to go into place.

For cartridges, we believe that sheet aluminum bronze will prove to be unrivalled by any composition now known, for it is the only cheap metal not affected chemically by gunpowder, and that in turn does not deteriorate the gunpowder when stored for a period of years. It is so strong, and so much less in specific gravity than brass or copper, that the cartridge shell may be made of one-half the weight now required. Aluminum bronze is likewise most admirably adapted, on account of its enormous tenacity and stiffness and resistance to all forms of corrosion, for torpedo boat cylinders and steam boilers, seamless tubes, stay bolts, and particularly rivets, where great strength is required and there is any tendency to shear off the heads, for it is as easy to obtain 50 tons tensile strength in an aluminum bronze rivet as it is 25 tons in iron.

The Future of the Process is one of great promise, and will undoubtedly lead to the production of cheap and pure aluminum itself within a very brief period.* Indeed, the Cowles Electric Smelting Company asserts, on the back page of its pamphlet, that it expects to put the pure metal on the market within a year. When you are informed that we can charge iron, manganese, tin, copper, nickel, &c., with a very high percentage of metallic aluminum in this furnace, and that, also, without any base metal in the furnace, we can saturate the charcoal contained therein with metallic aluminum, most of which will be in a state of mechanical mixture with the carbon; and further, that we have produced specimens of aluminum 99 per cent. pure in at least three different methods by the electric furnace; and that notwithstanding all this we have not made much of an effort in this direction, the majority of you will agree that the great problem of producing pure and cheap aluminum is practically solved. How cheap this method will be you may judge from the fact that, at our Lockport works, which will have a capacity of only two or three tons per day, we expect to produce the aluminum in bronze with the little silicon contained in it at a cost not to exceed 40 cents per pound, or with copper at 12 cents per pound, the bronze will really cost but about 15 cents per pound.

In truth, "The Cowles Electric Smelting and Aluminum Company" is founded upon the faith that ere long we shall be marketing pure aluminum at a cost not exceeding 50 or 60 cents. per pound. An appreciation of how cheap this would be, can be had from the fact that one pound of aluminum would go about as far as three and one-half of copper, it being that much more bulky, and in reality it would be about as cheap as copper at 18 cents. per pound, without counting its vast superiority over copper for many purposes on account of its greater lightness and resistance to corrosive influence.

Thanking you, gentlemen, for your attention, I would respectfully call your attention to a collection of ore, carbon, white bronze, furnace products, specimens of sheet and wire, and other manufactures of aluminum bronze, that I have brought with me for your inspection.

[NOTE.—Since the above paper was filed with the Secretary of the Institute, it was found possible to prolong the length of the "heats" of the furnace to five hours, and increase the charges to over 100 pounds in weight, and during the same week a button of cast aluminum, five ounces in weight, was separated from the matrix of carbon, in which it was reduced by a process so simple and economical, that the production of pure aluminum from its oxide by the agency of heat and carbon only, is now demonstrated beyond all question.—E. H. C.]

* See Note at end.

DISCUSSION.

Mr. THOMAS SHAW: What do you estimate to be the cost of operating with water-power, as compared with steam-power?

Mr. COWLES: Water-power is certainly the cheaper, where it can be had at first cost.

Mr. A. E. OUTERBRIDGE, jun.: Have you any idea, approximately, of the temperature developed in your furnace?

Mr. COWLES: We have no opinion on this point, further than that the temperature is probably as high, or higher, in spots, than that of the arc, because of the fact that the heat is prevented from being wasted or dissipated, owing to the heat-retaining character of the surrounding walls.

Mr. OUTERBRIDGE: Does the metal flow away after reduction?

Mr. COWLES: No; the capillary action of the pulverised charcoal prevented this from taking place, just as fine flour or dust sustains drops of water and prevents them from flowing away."

Mr. SHAW: How often is it necessary to renew the linings of your furnaces?

Mr. COWLES: About once a week.

Prof. W. H. GREENE: Have you succeeded in reducing metallic calcium from its oxide?

Mr. COWLES: Professor Mabery has reported that we have done so, and Professor T. Sterry Hunt, who spent some time with us in Cleveland observing the action of our furnace, witnessed the run or heat in which the reduction was made. We have also reduced metallic boron from boracic acid, and silicon from silicic acid.

Dr. GOLDSCHMIDT: I saw at the meeting of the American Association for the Advancement of Science, two forms of silicon, one consisting of black crystalline particles, and the other greenish in colour. What is the difference between them?

Mr. COWLES: The greenish material we believe to be partially reduced silicon, or a new sub-oxide of silicon, not hitherto observed. Our reasons for this are that it is always found at an intermediate position, between the completely reduced silicon at the top and the fused silica at the bottom.

Mr. OUTERBRIDGE: Do you observe any relation between the percentage of silicon in your alloys and their ductility?

Mr. COWLES: We believe that the small percentage of silicon obtained in the alloys is a benefit to them, by increasing their tensile strength. This is effected by the metallic silicon absorbing any oxygen taken up by the metal in the process of casting, and rising to the surface as silica, thus freeing the metal from such impurity. This is proven by the fact that on European aluminum bronzes, thus far made, have exhibited as high a tensile strength as our bronzes, by as much as 20 per cent. The highest test of an aluminum-bronze casting other than ours, that we know of, is 94,000 pounds per square inch, while a casting of ours, which was tested some two weeks ago at the Washington Navy Yard, by Lieut. Hall, exhibited a tenacity of over 114,000 pounds per square inch, and we can, and frequently do, make to order, metal of 100,000 tensile strengths in castings, while 90,000 pounds tensile strength is our ordinary standard for 10 per cent. bronze; in other words, we let none go out of our works having less than 90,000 strength.

Mr. ——: Why does not the molten metal short circuit the furnace?

Mr. COWLES: One reason for that probably is, that as the metal becomes highly heated its conductivity is greatly diminished; another, possibly, is that the formation of an alloy, such as aluminum bronze, may still further decrease its conductivity, since it is well known that alloys are often higher in resistance than their constituent metals; but above all, the great preventive would be the volatilisation of the metal as soon as any considerable portion of the current started through it, which would cause a boiling of the mass and thus break up any contacts that should be made between the electrodes. At least, whatever may be the true reason, we find that we have had little or no trouble from this cause during the year that we have been in operation.

The SECRETARY: A few comments, Mr. President, on the general bearings of this important subject may not be out of place here, for the benefit of those who may not be familiar with its technical features. The late Sir William Siemens, I believe, was the first to suggest the utilisation of the intense heating effect of the voltaic arc for metallurgical purposes. He carried this suggestion into practical effect, also, by constructing what he termed an "Electric Furnace," and at the Southampton meeting of the British Association, in 1878, he described a series of experiments which he had made with this furnace in melting steel, nickel, platinum and other refractory metals, which demonstrated the enormous heating effects attainable by this means.

It is worthy of note, however, that nowhere in this paper does it appear that he had conceived the idea of using his furnace to effect chemical operations such as the reduction of refractory ores. That this should have escaped the notice of an intellect so keen, and so thoroughly practical in its bent, is quite remarkable. It remained for the Cowles brothers to take this step in advance. They conceived the idea of a metallurgical furnace in which the reducing action of carbon should be greatly reinforced and exalted by the enormous heat of the electric arc. The results which they have succeeded in obtaining, Mr. Cowles has set forth in his most interesting paper, and are visible in the instructive array of specimens which he exhibits before you.

In view of what has been accomplished so early in the history of this invention, it is risking nothing to predict that when its capabilities shall have been fully developed, it must prove of great advantage to the metallurgical arts. Already, it is almost as good as assured, that it has solved the difficult problem

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of producing aluminum cheaply, so that we may expect soon to see it taking the leading position in the arts for which its remarkable qualities appear to fit it so eminently, and from which its high cost, as compared with copper, tin and other useful metals, has hitherto debarred it. The extraordinary reducing power of the electric furnace justifies the expectation also, that with its aid, the world may soon be enriched by the gift of many alloys of unknown and remarkable qualities.

The happy conception of the Cowles brothers has armed the metallurgist with a vastly more powerful weapon than he has hitherto commanded, with which he will be able to achieve results heretofore unattainable. I am sure you all join me in offering them the hearty congratulations of this Institute.

At the close of the discussion, the meeting passed a unanimous vote of thanks to Mr. Cowles for his able and interesting address.

SOME POINTS IN ELECTRICAL DISTRIBUTION.

By Prof. GEORGE FORBES.*

WHEN I had the honour, just a year ago, to give a course of Cantor Lectures to this Society, on the distribution of electricity, the subject had not till then been treated in a systematic manner. When I was this year asked to read a paper before the Society, I eagerly availed myself of the opportunity to take up the straggling threads, and say a few words on the subjects which were previously but inadequately treated.

Allow me to remind you that, in my lectures, I described five different ways of laying the mains, each one depending upon a different method of connecting the dynamo machines and lamps. Three of these may be called direct systems, and two indirect. Each system has special advantages when applied in suitable cases, and when an engineer is designing a scheme of distribution he carefully considers the *pros* and *cons* of each system as applied to the special case, and very often he has to go through the whole calculations of the scheme according to several different systems.

The three direct systems are the parallel, series, and parallel-series methods of attaching lamps to the main conductors.† The two indirect systems are with the use of secondary batteries and secondary generators. Each of these systems is capable of being varied in the details of its application, and each is specially applicable to particular cases.

The first or parallel system is generally most suitable for small installations, but the cost of conductors becomes extravagant when the area is extended, except in very special cases. The series system is at present only used for arc lights, sometimes with the insertion of a few glow lamps in parallel to replace an arc lamp.

The third system is admirably suited in every case where the number of lamps in use at any time is constant, and may perhaps be modified so as to be applicable to other cases. Smaller conductors can be used on this system than on the first, and this effects a very great economy.

Having recalled these points to your notice, I need say no more, as I treated these three systems and their modifications very fully in my Cantor Lectures.

I thought I had spoken strongly enough about the enormous cost of the main conductors, and the necessity for selecting that size of conductor which is the most economical. We must not use too small a conductor, for then the waste of energy in heating the conductors would be enormous. Nor must we use too large a conductor, for this means buried capital. We must select that size which balances one cause of loss against the other so as to give the maximum economy.

I find, however, that, while this axiom has been accepted as such in this country, some writers from America still try to uphold the fallacious views which have hitherto been in vogue there. I have noticed more than one criticism from America, by people asserting themselves to be connected in some way with some of the Edison companies, who protest against my statement that the three-wire system effects an economy of copper of only 25 per cent. over a two-wire system. The difference between us is that I start with the *axiom* that we are to use the most economical size of conductor. My critics start with the *assumption* that they shall use a conductor which shall waste exactly 10 per cent. of the energy. In this way they use a conductor which is not the most economical, and they show a saving of 62½ per cent. of copper over the two-wire system, but with a possible extra waste of energy of 62½ per cent. I said in my Cantor Lectures, and I repeat it this evening, that this manipulation of figures may suit American financiers, but it is not electrical engineering.

Before proceeding to discuss the indirect methods of distributing electricity, which is the main point I wish to touch upon to-night, I wish to supplement my remarks on series lighting by a statement of what has been done in the last year. I expressed a hope that more attention might be given to the lighting of houses by glow lamps in series. I further showed that it was only by means of a constant current flowing through glow lamps in series that the regulation of each lamp could possibly be effected on economical principles. This regulation must be accomplished by altering the length of the filament in the lamp. This has never yet been done, but if inventors once realise the importance of the object to be attained, I feel sure that we shall not have long to wait for the solution of the problem. Now I am delighted to be able to inform you that during the past year at least one inventor has been applying himself to the placing of glow lamps in series. Mr. Bernstein, who has paid so much attention to the system of glow lamps, has worked out the problem of using lamps of low pressure and large current in series. He has boldly taken extreme measures, and proposes to use lamps of 6 volts and 10 ampères. And here he has got over a difficulty I referred to in my Cantor Lectures. I said that there was no economical way of preventing a broken lamp from extinguishing all the others on the series. Passing part of the current through a shunt whose resistance is 100 times that of the lamp would be very expensive if we had in use lamps of the ordinary type, but with a lamp whose resistance is a fraction of an ohm, the expense would be trifling. When the lamp breaks, the current in the shunt is increased so as to release a contact which short-circuits both the lamp and the shunt.

I still think, however, that the loss of energy by heat conduction at the terminals, may be very great in lamps of so low a resistance; Mr. Bernstein tells me it is 10 per cent. Still I can well foresee that, even if a very sensible loss of energy occurred, the economy and convenience of using such a system might be amply sufficient to warrant its adoption in many cases.

I congratulate Mr. Bernstein on his work in the past, and would urge him to develop this idea more fully, and I can assure him that I, for one, will give the fullest consideration to the system when preparing the plans for electric light installations.

I should like also to take this opportunity of congratulating other makers of electrical appliances on the advances which have been made since the date of my Cantor Lectures. I should like especially to congratulate Mr. Swan on the improvements he has made in the manufacture of glow lamps; the Messrs. Siemens and Messrs. Crompton on their successful construction of very large dynamos; Messrs. Elwell and Parker on their great improvements in the details of construction of dynamos and motors; and the Electrical Power Storage Company on the continued improvements in their secondary batteries. I would equally congratulate Messrs. Willans and Crompton for the continued improvements in steam-engine governors, for keeping the current from a dynamo or the pressure at any point in the circuit constant; likewise Mr. Ferranti for having brought out an electric current meter which promises to fulfil all the wants of engineers and the public in this direction; and last, but by no means least, Messrs. Woodhouse and Rawson for various new devices which will go far to assist in designing and carrying out many schemes of lighting; and I would specially mention their automatic cut-out, adjustable to any strength of current, which, though not so new as some other devices, has only been brought prominently to my notice during the past year, and whose simplicity and reliability give me great confidence in employing it. I must not fail to include here, as a subject for congratulation, the rising esteem in which secondary generators are held, and the improvements which have been made in their manufacture.

When I add to this list the admirable lamp-holder of Mr. Alfred Swan, Varley's adjustable carbon resistances, and other small but useful accessories, I think you will agree with me that the facilities at the disposal of the engineer for designing a satisfactory scheme of electric lighting, and which have been added to his store during the past year, are very abundant.

About one of these appliances I should like to add a few words.

First, I may say that the Electric Lighting Act was rendered abortive, if for no other reason, simply for the want of an electric current meter which was in all points satisfactory. In the year 1882, a patent was taken out for a meter in which the current passing round an electro-magnet created a field where mercury was placed, which rotated when the current passed through the mercury from the centre to the exterior of the field. If the magnetism be proportional to the current, and the friction be proportional to the square of the velocity, then the number of turns completed in any time is a direct measure of the total quantity of electricity which has flowed through the meter in that time. The marked improvements introduced into this meter by Mr. Ferranti consist in the perfection of the magnetic circuit, and the introduction of an almost frictionless mechanism for correcting the revolutions and showing them on dials like a gas meter.

I have many of these appliances on the table which any members of the audience may examine at the conclusion of the paper.

In referring to my Cantor Lectures, let me make a few remarks about a double Table which I introduced to assist engineers n calculating the size of mains required in any installation. These Tables have been copied into a number of technical journals and books of reference, but in nearly every case there is no word of explanation how to use them. I have found these Tables of such paramount convenience that I think it right to call attention to them once more. The economical size of main depends upon three variable factors—the price of laying down a ton of copper mains, the interest to be charged on the capital sunk in mains, and the value of an electrical horse-power for the number of hours that is to be utilised during the year. My Table is divided into two parts. Look along the line in the second part which relates to the percentage on capital which you propose to use,

* A paper read before the Society of Arts, February 19th, 1886.

† In my Cantor Lectures I used the terms multiple arc, series, and multiple series. I prefer the terms now advocated.

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until you come to the column relating to that price of copper which you propose to use, and you then find a number printed which we may call the auxiliary number. Now take the first part of the table and look along the line which relates to that value of a year-horse-power which you propose to use, until you find the auxiliary number; the heading of that column of figures tells you the size of main per 1,000 ampères which is most economical to use according to the data you have employed.

I will now remind you of the position in which we were left after a full discussion in the Cantor Lectures of the three direct systems of distribution. The parallel system, or the three-wire system is admirably adapted in cases where the farthest lamp of the district is within two hundred yards of the central station. So soon as you go to greater distances the cost begins to increase in an alarming ratio. Hence this system would be applicable to a large district only by having engines and dynamos put down at a very large number of small stations. Now, a station is not worked economically unless the engine driver and stoker are fully employed, and the maximum economy cannot be reached with less than about 1,000 horse-power. Thus the parallel system is only applicable to cities so densely populated as to have a consumption of about 10,000 16-candle-power lamps in a radius of 200 yards. But in most districts of this class space is valuable, and a large number of such stations would be very expensive. We must, then, in the parallel system of distribution, be content to work at a cost which is above that of the ideal of economy. There are many cases where the great simplicity of such a system does actually make it worth while to sacrifice this ideal of economy, and when an engineer is consulted on such matters, it is his duty to estimate the exact loss from not strictly following the ideal economical rules before adopting or rejecting this system. In order to make a parallel system effective, the central station must use distributing boxes, the methods of placing which are described in my Cantor Lectures.

The cure for all these evils would be found if a thoroughly satisfactory system on the parallel-series plan were known. In that case high tension electricity might be used involving smaller conductors. Thus the central station might be at a distance, where land is cheap, and it might be of any size, so that all the works would be in the same place, as they are in gas distribution. Here the only departure from the ideal of economy lies in the length of the conductors to the district which has the supply. But these conductors are comparatively small, and no engineer would recommend the adoption of such a system unless he found that the economy of having the works out of the expensive district counterbalanced the extra expense in mains.

Now I regret to be compelled to say that, after discussing all the ingenious plans on the parallel-series-system proposed by Mr. Edison and others, I arrived at the conclusion that at this time there is no parallel-series system of distribution which is quite satisfactory. I do not say that such a system cannot be devised, but I do say that at this moment no such system is available to the electrical engineer, except in the case where the same quantity of electrical energy is consumed in any district at all hours during which the current is being used. There are some cases where it will pay to insert equivalent resistances when lamps are put out. These cases are rare, but they must not be lost sight of by the engineer.

Having in the Cantor Lectures discussed all the direct systems of distribution, I will complete my outline of this part of the engineer's profession by an examination of the two indirect methods which I formerly touched upon only lightly, viz., secondary batteries and secondary generators.

Secondary Batteries.

I have been given to test about a dozen different kinds of secondary batteries, of which I have found some four or five to be good, and the others mostly worthless. I can say this, that at the present moment secondary batteries can be supplied by certain makers which are to be relied on with careful usage, and which give us 70 to 80 per cent. return for the energy expended.

Now it might be asked what are the advantages of storing the energy if you lose 25 per cent. by doing so. The first advantage is that a breakdown in the machinery does not then interfere with the supply. The second advantage is that the steadiness of the supply does not depend upon the speed of moving machinery. The third and great economical advantage is that your expensive engines and dynamos are paying interest 24 hours of the day, instead of only a few hours, by doing their work; and a smaller supply of engines and dynamos suffices.

Now this is all very well, so far as having secondary batteries at the point of supply is concerned, but it does not help us much so far in the great problem which we have attacked, viz., that of electrical distribution. But the improvement of secondary batteries led to great hopes of a cheap system of distribution. It was said, "Put your generating station at a distance, on cheap ground, carry a current with high potential through light conductors to the district to be lighted. Pass the current through some thousand accumulators in series, placing these in batches of 50, say, each, in cellars, to light up a small district." The original idea was to keep the service wires permanently attached to the two ends of each set of 50 cells.

Now this plan is very beautiful if only it would work. But it will not work. The consumption being small from some of the cellars and large from others, and the same charging current going through all of them, the cells become overcharged in many cases, and this is injurious.

Another plan was proposed which I described in my Cantor Lectures. This was to introduce an arrangement to indicate when the cells were fully charged. By having two complete sets of batteries in each cellar, the indicator caused a rocking switch to act which switched the fully charged battery off from the charging mains on to the service mains, and at the same time switched the second set, which had, up to that time, been supplying the service mains, on to the charging mains. Here I would point out that, independently of the fact that we have no reliable indicator to show when the cells are fully charged, this only moves the difficulty back one step. For it will often happen that both sets are fully charged, and yet we are obliged to send current through one of them. This plan was tried at Colchester, but of course it had to be abandoned. If we had a true indicator to show when the cells are fully charged, the more sensible plan of using it seems to be to cause the indicator to disconnect the cells from the charging mains and connect the charging mains metallically. There would, of course, be a great fall of potential in lamps immediately after switching off the supply current, but the charging of the cells might be done by day or after midnight, during which time lamps are not very much used. I think that even this small difficulty might be got over by causing the indicator when it acts to increase the number of cells which lead to the lamps.

I suppose the most reliable indicators which could be used are those depending upon the specific gravity of the solution or the weight of the negative (oxydised) plate. Unfortunately, it is seldom found that a number of cells working in series become charged at the same time.

In fact, it is not very generally known that the most satisfactory plan for charging secondary batteries is to do so in quantity or parallel. When this is done, every cell is fully charged exactly at the same time, and all give off gas at the same moment. If there be any possibility of short circuiting, however, fusible plugs or other cut-outs must be inserted.*

To have a thoroughly satisfactory installation, it is necessary that the cells may be left in their secluded retreats without attention for long periods. I think I can safely say that cells can be so left if fairly treated. But the question is whether any scheme of distribution hitherto considered does give them fair treatment. If attendants have to be continually going round to inspect cells, this expense must be carefully calculated so far as is possible, and taken into account.

Now let me say a few words as to the improvements in secondary batteries. First, I may say that there is now no doubt that they can be made, and are made, by several makers of so good a construction that they can be used for years. I will not fix the number of years, because none of the most perfect ones have yet failed. Secondly, it seems to be conclusively proved that not only does no buckling take place, but there is no fluting or blistering if the plates are originally good, and if the air has not been allowed to reach them. Thirdly, we know that in overcharging them we do not injure them, but merely waste current. These are important facts, and are all we want for an installation where the state of the cells can be always under examination. For central station lighting we want something more. We want the cells to take current from the dynamos when they require it. For this we must have an indicator on the cells to work a switch, according to the state of charge of the current. Up to the present no satisfactory master cell has been devised. Those which depend on the gas given off do not act equally promptly with currents of different strength. The most promising system is one in which the state of the cell is shown by the specific gravity of the liquid. Very little ingenuity is required to develop this into a satisfactory system. But we cannot depend upon one master cell since it is only when charging in parallel that all cells act alike. If we have several master cells in each battery, all of which must act together to cut off the dynamo, I think we might depend upon their action. The function of the switch is—first, when the E.M.F. of the battery is too high, to cut out the dynamo circuit from the battery, to give a through connection to the dynamo current, and to switch in two additional cells to the lamp circuit; second, when the E.M.F. of the battery is too low, to break the charging current, to connect the battery to it, and to cut off two cells from the lamp circuit. These are all ordinary things which can easily be done.

But even without automatic action of this sort there are many large installations where it would be economical to use secondary batteries even if attendants had to be continually examining the state of the cells. The engineer who is designing an installation, if he does his duty, calculates the cost of every method of working which can be feasible.

The cost is of course an important item, and were it not that this system introduces a great saving in copper conductors and machinery, it would often be too expensive to work. We may take the cost of batteries at about £3 per lamp of 60 watts. The saving in copper conductors is proportional to the number of batteries put in series. There is also a saving in dynamos and engines. If we take four hours as the average time of using the lamps, we charge them, say, for six hours in the day time, and we use the dynamos as well as the batteries during the greater part of the night. Thus we require batteries and dynamos for only about one-half of the number of lamps generally in use. This brings the cost of batteries down to £1 10s. per lamp, and the cost of dynamos and engines from about £1 per lamp (the usual cost

* Even in this case we may have a partial short circuit, which will drain the current and yet will not cut out the cell.

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for a direct service) to 10s. per lamp. This makes a total cost of £2 per lamp, as against £1 by a direct service. When we have made a further reduction for diminished size of conductors, and an increase for additional attendance, we are in a position to compare the two systems. But these figures vary so enormously that it is impossible to estimate them unless one has the details before him. We may say safely, however, that in large districts there is economy in secondary batteries, and in small districts in a direct service. But the advantage of not being dependent on the constant perfection of machinery is very great, and avoids the necessity for so complete a duplication of the parts. Of course the cost of working must also be made out, allowing for a loss of at least 20 per cent. in transforming through the secondary batteries.

The number of ways of using secondary batteries is great, but there are no engineering difficulties in the distribution, and I may, therefore, content myself with having drawn attention to the general advantages of using them.

Among the many special appliances used in this kind of work, I am glad to be able to show you some useful things supplied by the Electrical Power Storage Company.

Perhaps the most important of these is a switch for large currents, in which a number of concentric tubes have a longitudinal slot into which the arm of the switch is forced. The split tubes have a certain amount of spring, and literally cut into the arm of the switch, and so make good metallic contact. The one before you has been thoroughly tested with 1,500 ampères passing through it.

Another appliance is an automatic switch to reduce the number of cells in the lamp circuit when the dynamo is charging the cells and *vice versâ*.

A third is a cut-out to prevent damage to the charging dynamo by an accidental falling off of speed. It has this peculiarity, that it puts the battery in circuit again so soon as the dynamo resumes its functions.

In concluding this part of my subject, I would draw your attention to the scheme of lighting the Vienna opera house. The dynamos are by Messrs. Crompton, of 72,000 watts each, and are driven by direct acting Willans and Robinson engines. I am told that they give an electrical horse-power for 3·7 lbs. of coal. The secondary batteries are supplied by the Electrical Power Storage Company. The three-wire system is adopted, 110 cells are ordinarily in use with each circuit, and six additional ones are available to keep the electric pressure constant.

Secondary Generators.

I now come to speak of secondary generators, and since the principles which regulate their action are rather novel, it may be well if I spend a little more time in describing their action than I would otherwise do in a lecture treating chiefly of the manner of laying main conductors.

Everyone knows the principle of the induction coil. It consists of a core of iron surrounded by a coil of insulated wire called the primary coil, and by another one of insulated wire called the secondary coil. The secondary usually contains a larger number of turns and finer wire than the primary. The current in the primary is alternately made and broken by a simple automatic means. This magnetises and demagnetises the iron core. This is equivalent to introducing and withdrawing a magnet into and out of the secondary coil, and sets up currents in the secondary coil.

The electromotive force created in each turn of the secondary coil is measured by the number of magnetisations per second, and by the strength of the magnetisation. The latter is generally proportional to the number of turns in the primary, and to the current flowing through it. Thus the electromotive force in the secondary coil depends (1) on the number of turns in the primary; (2), on the number of turns in the secondary; (3), on the strength of current in the primary; and (4), on the number of makes and breaks in the primary current. Thus by having a large number of turns in the secondary coil, and a small number in the primary, a very high electromotive force can be obtained from a small battery connected with the primary.

If, on the other hand, a high tension interrupted current were sent through the fine wire coil we could get a large current from the thick wire coil.

Now, to feed a number of glow lamps in parallel, we require a large current, but this requires a large conductor. Here it was proposed to use a high tension alternate current (which acts just like an interrupted current) by a thin conductor from the works to the place of consumption, and there to transform it into a current of large quantity.

Then, again, another idea was thrown out. This was to carry the alternate current by a thin conductor round a large district, and at intervals to pass it through the first coil of induction coils, using the second coil to supply the lamps. Thus we should have a high tension current disconnected from the service conductors, and furnishing them all with a low tension current.

Induction coils used in this way have been called secondary generators or transformers. The perfection of manufacture of such apparatus consists in getting a maximum of induction and a minimum of heating. This has been admirably accomplished in the generators of Messrs. Gaulard and Gibbs. Instead of wire, the coils are made of copper discs, or flat rings split at one point, and with ears projecting outwards at the split. These discs alternately belong to the primary and secondary circuit, and successive discs of each circuit have the ears soldered together in such an order as to make up a spiral. The iron core is, of course, made of iron. [One could not reasonably expect it to be made of wood. —Eds. Elec. Rev.]

Although the even discs belong to the primary and the odd ones to the secondary, it does not follow that alternate discs should be coupled together. We may couple the 1st, 5th, 9th, &c., together, and also the 3rd, 7th, 11th, &c., so as to form two secondary circuits, which may be combined in parallel. The number of possible modifications of this sort is very great.

When the primary coil is magnetising and demagnetising the iron core, the latter sets up a counter electromotive force in the coil, and thus the current is largely diminished. But when there is no external resistance in the secondary coil, that coil being short circuited, then any magnetisation and demagnetisation of the core starts a current in the secondary coil, opposite in direction to that in the primary and almost equal to it. Thus the iron cannot get much magnetised, for it is surrounded by two opposing currents almost equal in amount. In this case, therefore, the primary has little or no counter electromotive force opposing it, and consequently it flows more freely. This explains a thing which often puzzles the beginner, viz., that with a constant electromotive force in the dynamo the current in the primary is stronger when the secondary circuit is closed than when it is open.

Very little energy is expended in magnetising and demagnetising iron wires. Thus there is really no loss of energy in the transformation, except that due to the heating of the conductors of which the coils are constructed, which is equal to the square of the current multiplied by the resistance. The loss of energy, which could not be accounted for, has been shown by Prof. Ferraris to be less than 1 per cent., and the practical efficiency of the generator amounts to as much as 95 per cent.

The theory of the secondary generators is very like that of the alternate current dynamo, if the reversals of magnetism of the armature were given by reversing the currents in the field magnets instead of by mechanical motion.

Coming now to distribution by secondary generators we find we must use the same principles as in direct distribution.

Parallel Distribution.—Let us take this case first. To do this economically we might lead two thin wires over the district and couple secondary generators to them. The condition of being able to have constant electric pressure in the lamps is that the electric pressure at the terminals of the primary should be constant. Here we meet the same difficulty as was experienced in direct supply. Consider three generators—1, 2, 3, fig. 1. If the lamps are all on in all three cases, then the pressure for No. 3 is less than for No. 2, and that again is less than for No. 1. Suppose you try to rectify this by using lamps of lower pressure at the far station. In this case suppose the lamps in No. 2 are extinguished, then the pressure in No. 3 will go up and tend to injure the lamps. If you try to correct this at the central station you will lower the pressure of No. 1 till perhaps it only burns red. This difficulty is exactly the same as in the direct service. The remedy is of the same kind. You must use the generators as distributing boxes (see my Cantor Lectures, 1885), with separate wires from the engine to each generator, each one being fed with a different pressure from the engine house. Fig. 2 shows this arrangement. There is no objection to it except (1) that you must use a large

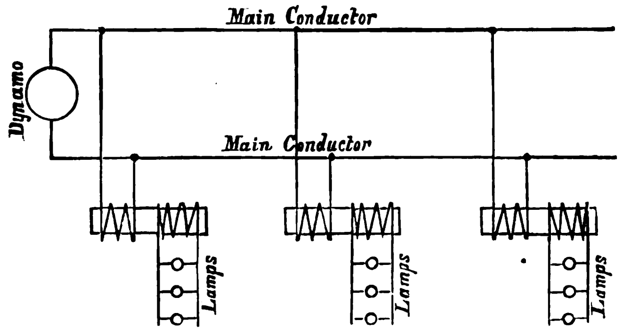

Fig. 1.—Secondary Generators in Parallel.

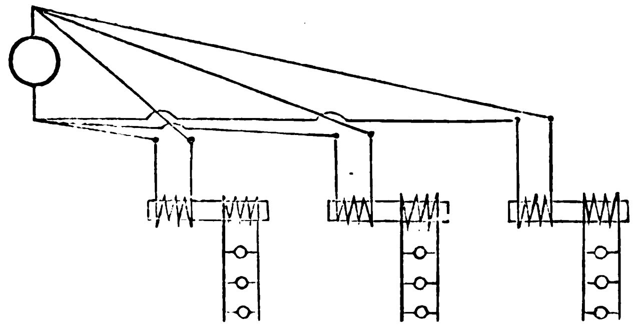

Fig. 2.

Distributing Boxes replaced by Secondary Generators.

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number of conductors, and (2) you introduce the full pressure of the high tension current into each house.

Finally, we come to distribution by generators in series. Here we have the best effect. A single wire (Fig. 3) goes round the circuit; if a double wire is used, to prevent affecting telephones,

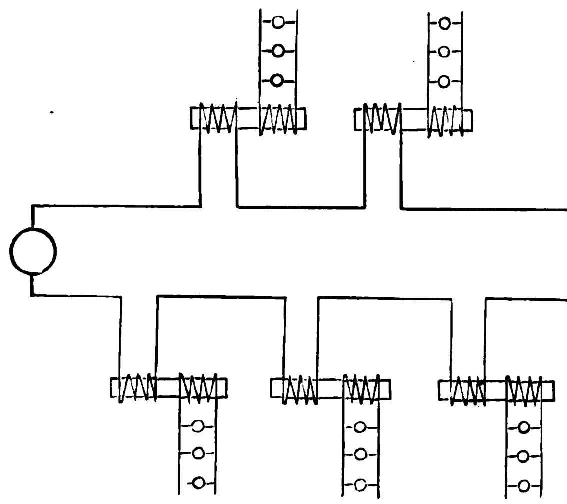

FIG. 3.—SECONDARY GENERATORS IN SERIES.

it is half the weight, and generators are alternately put on one wire and the other all round the district, and each pair of wires ends at a point far from the station. Suppose we use 10,000 volts, we may have 100 generators in series, each using 100 volts, or we may make any other arrangement. If it were done as I say, then following out the data of my Cantor Lectures, a wire of one square inch section will carry current enough for 100,000 lamps each consuming 60 watts.

In this arrangement we must send a constant current through the circuit. This is actually done by the introduction of resistances. It ought to be done either by an electric governor on the steam-engine, or by compound winding the alternate current machine, a matter about which there is no difficulty at all.

But how are we to attain to constant electric pressure in the lamps when we have got our constant current? This is a problem which has puzzled many people, and many have come to the conclusion that it is impossible to do it without mechanism. This used to be done by automatically introducing the iron core farther or less far into the coils. It is now done without any relative movement of the parts. This is the last triumph which has been added to a series of laborious experiments which year by year have brought us nearer to a solution of our difficulties. I am not at liberty to explain the *modus operandi*, but I have seen it at work, and it is very satisfactory.

The theory of secondary generators has been so little studied, except by specialists, that I have thought it might be advantageous to many if I added to this paper the formulæ which represent the electric current and pressure as depending upon the resistances and mutual induction of the various parts. These data will be found in an Appendix to the present paper.

I do not think it would be consistent with the objects of this paper to describe the specific differences between different kinds of secondary generators, or to attempt to give reasons for choosing one of these forms rather than another. I would merely draw attenton to the brilliant experiments on self induction by Professor Hughes, described in his introductory address as president to the Society of Telegraph Engineers and of Electricians. Professor Hughes has discovered a new and hitherto unnoticed source of waste of energy in self-induction, to remedy which it is essential to have the coils of the secondary generator made of discs.

I should also like, before leaving the subject, to dispel a growing error from the minds of some electricians. In speaking of different secondary generators, some persons are in the habit of speaking of one inventor's generator being used on a parallel system, another on a series system. This distinction is quite illusory. A generator made on any system is equally suitable for all kinds of distribution, and if an inventor states that his generator is only suited for one system of distribution he displays his ignorance, and shows that he has yet much to learn before he can say he understands the theory of secondary generators.

Last year, when speaking in my Cantor Lectures, I said that the Grosvenor Gallery installation would be followed with interest by engineers. I considered that it was a new test. Up to that time the method had been applied only to light districts where the number of lamps was constant. It was not proved that the method was suitable to the cases where lamps might at any moment be extinguished. Two things were necessary for this, (1) regulation of the current from the dynamo, and (2) automatic regulation of the electric pressure in the secondary circuit. Neither of these had then been accomplished in a manner which satisfied me, and I certainly considered it was a very bold step on the part of Sir Coutts Lindsay to adopt a system which was then so imperfect.

I am satisfied now that self-regulation of the secondary circuit is sufficiently perfect for practical purposes, even when the generators are in series; and I have pointed out to Messrs. Gaulard and Gibbs a further development which, in my opinion, will make their system even more perfect. The one weak point in the Grosvenor Gallery installation is the regulation of the current from the dynamo. Out of the four or five different methods by means of which this can be done, the worst has been applied up to this time, viz., hand regulation. The result is a frequent flicker in the lights. Still, when we consider that seven miles of route has been covered by the wires of this small association, and that on the whole great satisfaction is expressed by the users of the light, I must say that Sir Coutts Lindsay and his friends are to be congratulated on the great steps they have made towards success.

In conclusion, I wish briefly to allude to the present condition of electric lighting, and the prospects of economical distribution from central stations.

I have always maintained that there were three causes which retarded the progress of electric lighting.—(1), financial speculation; (2), the Electric Lighting Act of 1882; and (3), the unsuitability of the schemes of electrical distribution propounded by the contractors. I will say a few words on each in turn.

From the year 1881 to 1883 this country was the scene of a most senseless speculation, started by clever men of business, who took advantage of the interest in electric lighting caused by the Paris and Crystal Palace Exhibitions, and supported by dupes whose ignorance of electrical matters was only equalled by their want of common sense as business men. These men combined to purchase for large sums the right to use the apparatus of some particular manufacturing firm in a special locality. They never asked any competent person whether this firm's apparatus was better or worse than that upon which there were no royalties to pay. Those who were not clever enough to get out of the affair before the bubble burst were the sufferers, and the consequence was a panic in connection with electric lighting which has hardly yet subsided.

With matured knowledge confidence is again being restored, because the public learn from competent and disinterested persons that economical electric lighting can be accomplished without the necessity for paying the heavy royalties formerly demanded.

I trust that the warning of 1882-3 will not be lost on financiers, and that they will not be misled by untried but tempting schemes unsupported by capable men of science.

The next cause which has deterred electric lighting is the Act of 1882. This is an Act to give undertakers the right to break up streets in order to lay conductors, under certain conditions. It is these conditions which are so unjust. Some of our legislators, looking at the monopolies which exist in gas supply, are afraid that electric lighters will raise another monopoly. Consequently, they determined to hamper the electric lighting industry with conditions different to those imposed upon gas, and more stringent. They succeeded well, for they laid down such conditions that no sane man would invest in such a speculation. You would have thought it natural, I doubt not, that if the gas monopoly was truly so very irksome, the encouragement of a rival illuminant would have been the best cure for the evil, whereas our legislators acted as if they were parties interested in maintaining the gas monopoly, for they imposed such restrictions as rendered it impossible for electricity to be supplied to the public. Let me name one of their wise provisions. At the end of 21 years the local authorities can, if they please, buy from the company supplying electricity, the whole of their plant at the price of old material, without paying a farthing for goodwill or future profits, or past expenses in experimental and unprofitable work.

If, then, a company, after 21 years, were just making headway, and paying a dividend of 5 per cent. on their capital, the corporation would buy them up for perhaps a third of that capital, and get 15 per cent. But the case is even worse if the company is not yet earning a fair dividend, for then the corporation may hang over the company like a usurer over his victim, and each seven years it has the right to purchase the plant or not, and on the same terms as before.

Now, I agree with those who contend that electricity should be allowed to compete with gas under the same disabilities, and with the same advantages. This is not doubling a monopoly; it is splitting it into two, and destroying the monopoly, by allowing competition. If our legislators are not trying to uphold the gas monopoly, they must take this view. In any case, the public have shown that they will not submit to be deprived by legislation of this illuminant. The Board of Trade, I hear, have perceived their error, and are prepared to yield a little; but if they do not enable us to have electricity supplied to us, we, the public, must force their hand.

Still, electric lighting is not quite dependent on this Act. Local authorities have no penalties, and I would strongly urge them to take the matter up, for we have now arrived at a stage when it is safe and profitable to establish electric lighting on a large scale.

Again, you must remember that the disabilities of the Act apply only to those who lay their conductors underground and wish to break up the street. Sir Coutts Lindsay has taught us how to defy the Electric Lighting Act by passing the wires overhead. Those wires do not suffer like telegraph wires in snow storms, for the electric current melts the snow.

The third cause which deterred the progress of electric light-

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ing, was the unsuitability of schemes of distribution which were proposed. I was impressed with this weak point at an early date. Sir William Thomson was the first to touch on the matter when he announced his law of the economical size of conductors. But the engineer had no tables to guide him as to the safety of these sizes of conductors in the matter of heating. I attacked this problem first in order to clear the way for scientific methods of dealing with distribution. In a paper read before the Society of Telegraph Engineers and Electricians, in 1883, I computed from the facts well known to physicists, the heating of different sized conductors with different currents, whether the conductors were bare, insulated, or buried. I had already, in a communication to the British Association in 1882, shown by experimental evidence, that the generally accepted laws required modification when we dealt with small wires.

The way being thus cleared, I attacked the problem of distribution generally, studying the various schemes which had been proposed or put in practice. My conclusions were published in the Cantor Lectures in 1885, and the most useful result was to announce a series of definite rules which must be attended to in order to provide an economical distribution. Since then some progress has been made, and the present paper will, I hope, bring the subject pretty well up to date.

The work which I undertook has been laborious, but it has been a very humble effort. I have brought forward hardly a single fact which could not have been foreseen by the competent engineer. But I think I have saved others from wasting their energy in repeating much of the work which is laborious; and I also trust that the outcome is a set of rules to guide those engineers whose purely scientific knowledge may be a little defective from falling into the gross errors which have been so apparent in nearly all attempts at lighting by electricity on a large scale which have been made in the past.

I now close the subject for a time, and if the labour I have bestowed upon it leads in any slight measure to establishing one department of electrical engineering on a sound scientific basis, I shall feel that in the work I have undertaken I have been of some little use to my generation.

APPENDIX.

The following formulæ give the currents and electromotive forces, on the assumption that the magnetism of the core varies as the sum of the currents in the two coils.

The E.M.F. of the dynamo is assumed as being—

$$E \sin. mt$$

Then the primary current $= I \sin. (mt + \gamma)$
secondary current $= I' \sin. (mt + \gamma')$

$$I^2 = E^2 \frac{C^2 + r'^2}{r^2 r'^2 + (r + r')^2 C}$$

$$I'^2 = E^2 \frac{C^2}{r^2 r'^2 + (r + r')^2 C^2}$$

Where C is a constant;

r = resistance of primary circuit;
r' = „ secondary circuit.

Also the potentials at primary terminals $= v$;
and „ „ secondary terminals $= v'$;
where $v = V \sin. (mt + \phi)$
$v' = V \sin. (mt + \phi')$

$$V^2 = E^2 \frac{\rho^2 r'^2 + (\rho + r')^2 C^2}{r^2 r'^2 + (r + r')^2 C^3}$$

$$V'^2 = E^2 \frac{(r' + \rho')^2 C^2}{r^2 r'^2 + (r + r')^2 C^2}$$

ρ and ρ' being the resistances of the primary and secondary coils.

DISCUSSION.

Prof. HUGHES, F.R.S., said in his latest researches he had found that the maximum induction in iron took place when the iron was in the round form. If it was flattened, so that the contiguous portions of the current became separated from each other, the current was very weak; it had not one-tenth of its previous capacity. In the case of copper wire flattened, the reduction in the self-induction was about 50 per cent. Taking iron wire and passing a current through it, if you wished to have a secondary current parallel to it, the self-induction prevented the current acting on the secondary coil; in fact, the force of the electric current was used up in doing internal work. By flattening it, it re-acted on another wire to its full force, so that the energy which would have been used in self-induction, was transformed into the secondary current. He had not the slightest doubt that if this method were adopted, enormously more power could be obtained from the secondary coil. When two wires were flattened, the portions contiguous to each other did not re-act on each other with the same strength, but re-acted on any portion near; consequently, when there was another flattened sheet superposed, you had it in the nearest possible proximity. It was very remarkable that the same results at which he had arrived theoretically should have been worked out experimentally by Messrs. Gaulard and Gibbs, and they had arrived at the best possible conditions he could conceive for constructing a secondary coil. He had only one fault to find with it; the generator itself seemed perfect, but it required intermittent currents, and, therefore, it seemed to him there must be a loss in the line.

Mr. GAULARD (who spoke in French) thanked Prof. Forbes for his remarks upon the actual conditions and future prospects of the apparatus with which he was associated. He also thanked Prof. Hughes for his expressions respecting the mode of construction adopted, and in answer to the objection as to the great loss caused by the use of alternate currents for leads of great length, he said he could rely upon the experiments made with their apparatus, and reassure Prof. Hughes entirely on this subject. Their apparatus was constructed with two parallel circuits, forming spirals in the same direction. In order to obtain in the secondary circuit a variable electromotive force, they had contrived to unite in parallel and inverse directions the two circuits, and they had found that if in these conditions they sent through them an alternating current, the difference of potential at the ends of the spirals was directly proportioned to the resistance in the leads. If, on the other hand, they interposed in one of the connections a resistance, they found that the difference of potential at the two ends of the secondary circuit was, to a certain extent, directly proportioned to that resistance. From these observations it followed that if the leads consist of two parallel wires, and currents in opposite directions are sent through, not only no phenomenon of induction on the outer external circuit can appear, but no self-induction on these two leads can exist any more.

Mr. KAPP said he did not know much about the distribution of electricity, but he should like to add one more to the list of improvements which had been placed at the service of the electrical engineer, and that was the reduction which had been made in the speed of the dynamo. Machines were now running at half the speed of those constructed a few years ago, and in this way the chances of failure were enormously reduced.

Mr. B. DRAKE remarked that Prof. Forbes had drawn attention to the different ways in which electricity might be distributed for lighting purposes, but had not fully compared the relative advantages and disadvantages of the different systems. On behalf of secondary batteries, he would claim advantage in the practical impossibility of totally extinguishing a district through the failure of a single wire. No doubt there were many points which might be claimed on behalf of secondary generators, such as the first cost being less, and there being stronger metals in use which would be likely to last longer than lead plates, but at the same time the contingency of a station being extinguished all at once was an important consideration, and the fact of the engine having to be run to its full power whenever all the lights were required would more than balance the small extra cost of the accumulators in the first instance. The question had been raised as to the different details of apparatus necessary in connection with secondary batteries; they had been experimenting with every kind of apparatus for the last 18 months, with a view to ascertain how far it was really worth while to complicate the system by putting in automatic contrivances, and after designing all sorts of apparatus, they had come to the conclusion that the whole thing ought to be kept as simple as possible. When a cell was practically empty, you required only 2·2 volts to charge it with a certain current, whereas to get the same current through it when the cell was full required over 2·5; the cutting off of a definite number of cells was therefore practically not worth the cost of the apparatus. It was, however, found advisable to introduce some kind of automatic switch in any installation where the attendant ever had to leave the engine. There was again the question of the regularity of the light. If the engine power varied at all where secondary generators were used, that variation was transmitted throughout the whole district; if a bearing ran hot, all the lights felt it; and in addition to that, there was the variation which Prof. Forbes now said had been nearly overcome, which was due to varied consumption at different points of the circuit. With secondary batteries none of these evils occurred, and if some apparatus could be made reliable for cutting them in and out when fully charged, it seemed to him the solution of the problem would be complete. He agreed with Prof. Forbes that the specific gravity was the right principle to adopt in cutting out the accumulators, and that the master-cell system would be much improved by having two master cells which would have to be completed before the automatic cut-out would work. The difficulty with the specific gravity apparatus was this. The carrier which carried the whole apparatus had to float as well as the hydrometer, and in order to do that, the cell containing it had to be enlarged. In that way the bulk of the acid was enlarged, and consequently, the range in specific gravity became so extremely small, that you could practically do nothing with the small variation of the hydrometer. On the other hand, with the extremely small space which was necessary to get any appreciable variation, you had to employ such a small apparatus, that you could hardly rely on its working properly. The only way to get any results was by a system of relays, and that was difficult near accumulators, because the contacts got corroded by the acid. No doubt the advocates of the other system would be able to point out objections to secondary batteries, and he should be much interested in hearing them.

Mr. MORDEY thought the carbon resistance gauge shown was very similar to that which had been made for years by the Brush Corporation, consisting of a series of small carbon plates in a case, with a screw or lever arrangement to enable the resistance to be varied by alteration in the pressure. The principle had been used by Mr. Brush in his automatic regulator. The original principle he believed was due to M. Clerac, who communicated it to Prof. Hughes in 1867. With regard to lamps of low resistance,

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he might say that on some circuits at Eastbourne and also at Brighton, the plan had been in operation, not with so low a resistance as Mr. Bernstein used, but so low as to allow of three lamps in a group being used, instead of eight or nine; each lamp taking a current of 3·3 ampères, the normal working current being 10 ampères. The manipulation of a group of lamps was very much simplified when the number was reduced; and if it could be reduced to one, and a constant current could be maintained through the circuit, the perfection of simplification would be attained; but even where three had been used in a group, with about 15 volts at the terminals, the manipulation of each group was not a serious matter. Where people employed a large number of lights, they might object to turn out eight or ten, but the same objection did not apply to a group of three. He should like to ask if there was any advantage in using secondary generators in the manner shown in the diagram in parallel; it seemed to him that all the effect thus obtained could be obtained much better by the ordinary direct supply. The cost of leads and the whole of the problems connected with the question would be much the same in each case. Another point in connection with secondary generators was of great scientific interest, and that was as to the actual loss of energy in the iron of the core due to the rapid magnetisation and demagnetisation. There had been a great deal of discussion of late years as to whether any energy was really lost in this way, and it was a very difficult subject to work at, because it was almost impossible to eliminate the effect due to eddy currents, and that due to the turning over of the molecules, as Prof. Hughes would call it. In an ordinary dynamo machine, where the reversal of polarity was not so rapid, only 400 or 500 revolutions a minute, and the molecules only required to be turned over 800 or 1,000 times a minute, the difficulty was not felt, but in secondary generator coils, where the reversal of magnetism took place thousands of times in a minute, it would be very different, and he should like to know if the actual loss had been ascertained.

Mr. GAULARD, in answer to the observations respecting the great loss which might result from the retardation in the molecular vibrations, produced by a very great number of alternations—an opinion based upon certain facts observed in the use of a current having 1,000 alternations per minute—he would point out again that, in the experiments made by the International Jury of Turin upon the secondary generators by the most exact method, the calorimetric method, the current used had 16,000 alternations per minute; the yield had been proved to be 95 per cent. This is the greatest number of alternations obtained till now, by an alternate current machine of the largest type known, and perfectly sufficient, he thought, for producing the highest electromotive force which may be wanted from a practical point of view.

The Chairman, Prof. W. G. ADAMS, F.R.S., drew attention to the several points which had been raised by Prof. Forbes, and which had been brought out in the discussion, such as the relation of the size of conductor to the mode of distribution, and especially the part played by secondary batteries, and, again, the important applications of secondary generators so ably explained by M. Gaulard. Now that electric lighting was not going forward with such hot haste as it was two or three years ago, those who were connected with it had more time to think about the best and most efficient methods of doing the work, and the lull would be found to be a time of great profit to electric lighting. We may be thankful to Prof. Forbes for making the question of the size and arrangement of conductors so much his own, and for giving us the benefit of his researches in this direction. We must also thank him for so ably bringing before us in the Cantor Lectures, and in his paper this evening, the results of a great deal of thought and experiment on the different systems of lighting. Thanks to his and other researches, we may say that electric lighting is on a much more stable basis than it was three years ago. When it was stated that you could depend on getting out of storage batteries 70 or 80 per cent. of the energy employed, it was evident that a great step had been made during the last three years. Coming to the question of secondary generators, a very successful experiment had been made—indeed, it was almost more than an experiment—by Sir Coutts Lindsay. He might also refer to the experiment made some time ago by Messrs. Gaulard and Gibbs, in which they lighted up part of the Metropolitan Railway—from the Edgware Road Station to Aldgate in one direction, and Notting Hill Gate in the other—from one central station. The apparatus exhibited this evening showed that even then they had made very great progress, and that they had gone far ahead of the position to which they had then attained.

Prof. FORBES, in reply, said some of the points raised had been already answered. M. Gaulard had replied to Prof. Hughes by telling him of the effect of the double line; and he would observe that in doubling the line it was not necessary to double the quantity of metal, because, as shown in the sketch of the series arrangement, when you doubled the line, you tapped both wires, and therefore made the wires half the section they would otherwise have been. He ought to have congratulated Mr. Kapp on the improvements he had effected, but he should congratulate him on increasing his magnetic induction and the capacity of his machine, more than on diminishing its speed. It was perfectly true there might be less chance of failure in a machine when running at half speed than at the speed it used to run, but at what a tremendous cost that safety was obtained. The machine ought to do double the amount of work it did at that reduced speed. When there was a central station to light, the dynamo must be run at a reduced speed, but it must be made up for in another way by increasing the size. When there were large districts to light, it would be economical to have large machines going at comparatively slow speeds. When Mr. Drake came to look at the paper, he thought he would find that he had given full credit to the advantage he had mentioned of a district never being put in darkness through one wire breaking. He was sorry to hear that the sum total of 18 months work was, that they could not leave the batteries alone to automatic appliances to work themselves, and he trusted that Mr. Drake would reconsider that question. He hoped to see secondary batteries largely used in central station lighting, but if it involved the necessity of attendants going round to look after them and switch them in and out, it would be a serious drawback to their introduction. He ought to have mentioned that it was Mr. Drake who originally suggested to him the use of two master cells. In reply to Mr. Mordey, of course he did not mean to say that the use of carbon plates as an adjustable resistance was new, but he drew attention to this instrument of Mr. Varley's because he believed it was new, and it possessed advantages he had not seen in any previous arrangement. It was perfectly adjustable by the screw, and did not require knocking on the table to shake the pieces apart, as he had found with Mr. Brush's apparatus. With regard to the advantage of using secondary generators in parallel, he would point out that if the station were at a great distance, very thin conductors might be used to the generators. You might use a primary circuit of any series, and take as the secondary coil a number of discs in parallel, and so use a high tension current, thousands of volts in the primary, and yet have only 100, or whatever was required, in the house, and have all the economy of thin conductors. With regard to the loss of energy in magnetising and demagnetising, he agreed with M. Gaulard that it was an extremely minute quantity which could not be detected; the loss when a core of iron wire was used was very small indeed.

The CHAIRMAN then proposed a vote of thanks to Prof. Forbes, which was carried unanimously.

REVIEW.

School Electricity. By J. E. H. GORDON, B.A. London: Sampson Low, Marston, Searle and Rivington, Crown Buildings, 188, Fleet Street.

The object of this work is to give schoolboys a knowledge of electricity which, however incomplete, shall be of a useful kind. The work commences with the study of electric currents, showing what their principal effects are. At the end of the chapter (and, indeed, at the end of all the chapters) we have a series of questions given dealing with the subject matter which precedes them. In Chapter V., where the "Electrical Units and their Relation to each other, and to the heat and work units" are dealt with, we have a number of numerical examples given which must be of very great assistance to the scholar studying the subject. In the questions at the end of this chapter several are of a numerical nature, and it is much to be regretted that the answers to the same are not indicated. In many cases physical examples from other branches of science are given in explanation of particular phenomena; this is a great help, and is a point worthy of commendation. Taking the book altogether it is likely to prove very useful for the intended purpose, though a certain amount of the matter is, we think, rather beyond the range of boys of even high mental capacities. The book terminates with a series of examination papers, and here, again, we must express regret that no answers, to the numerical questions especially, are given.

Is it the Effect of Government Control?—In the course of some retrospective remarks, and speaking of the advances made since the death of Galvani on February 5th, 1799, the *Electrical World*, contrasting what has been done respectively in America and in England, says:—"The English Government last Thursday completed their sixteenth year of monopoly of the telegraph lines (February 4th, 1870). They have little improvement to show for their sixteen years of exclusiveness, except their record of a determined effort to crush out the telephone. On the other hand, during that period of only sixteen years we have tossed off the duplex, the quad., the telephone, and a few other trifles that are only born of or nurtured by a spirit of keen competition."

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NOTES.

Electric Lighting at the Edinburgh International Exhibition.—The members of the Executive Council and Committee of the Edinburgh International Exhibition dined together last week, Lord Provost Clark presiding. Among the speakers on the occasion was the Lord Dean of Guild, who said that they were blamed at first for aspiring to a guarantee fund of £25,000, which they put forward with some timidity, but it had now reached £36,701. They expected at the beginning to let 80,000 feet of space, but they had now allotted 109,685 square feet. They had also had the good fortune to have two excellent architects, and it had been said that the Exhibition was the best that was ever planned. The electric light would cost about £5,000, and their display of machinery would be greater than anything that had been in London.

Electric Lighting of the Post Office Savings Bank.—The trial test of the large installation, which has just been completed by the Maxim-Weston Electric Company, at the Post Office Savings Bank, was made last week in the presence of Mr. Blackwood (chief secretary, General Post Office), Mr. E. Graves (chief engineer), Mr. W. H. Preece (Government electrician), and other officials of the Post Office, and Mr. Hugh Watt, M.P., chairman of the Maxim-Weston Company, with other gentlemen. The installation has been divided into 36 circuits, and by means of a switch-board, weighing about 3 cwt., has been so arranged that any section of the installation can be switched on to any of the dynamos. This was done successfully in the case of 12 of the different sections, and run in all for about two hours. The Post Office officials expressed themselves well satisfied with the test made, and the installation was duly passed by them on behalf of the Post Office authorities; Mr. Preece further intimated his entire satisfaction with the steadiness of the light.

Electric Lighting in the City.—Colonel Haywood, the City Engineer, in his report of the year's work to the Commissioners of Sewers, says with regard to electric lighting :—" Upon the whole it appears desirable for the Commission to offer very liberal terms indeed to those willing to embark in the enterprise of supplying a fairly-sized district in the City with electricity rather than to undertake the work themselves. The risk of profit to the enterprise would be considerable, even if the promoters be paid most liberally for the supply they give; but whatever the cost may be, it would be a cheaper and a better way of obtaining a supply of electricity, either for the City of London or any part of the metropolis, rather than for local authorities to undertake it in the present condition of electrical science. Unfortunately, at the present time there is a complete stagnation in electrical enterprise upon a sufficiently large scale for the supply to a town or large district. This I believe to be solely attributable to the operation of the Electric Lighting Act, under which those embarking in such undertakings are fettered in many ways, and may, after a large expenditure and years of trouble, be deprived of the fruits of their labour with most inadequate compensation, just when success might begin to reward them. Nothing short of the repeal of that Act, or a fundamental alteration in most of its provisions, will bring capital into electrical undertakings again; and the Commission would, I believe, most usefully use its power and position in obtaining an alteration or repeal of the Act."

The Ball Electric Lighting System.—This system seems to be finding favour in the States, for we hear that the Ball Company is crowded with business, and is arranging an enlargement of its facilities of manufacture. Mr. H. W. Spang, a well known citizen of Reading, Penn., is president of the company, and under his direction the business is rapidly extending.

Electric Lighting of the Indian and Colonial Exhibition.—According to the *Society of Arts Journal*, the supply of motive power for the internal lighting of the forthcoming exhibition has been, as at the three former exhibitions, entrusted to Messrs. Davey, Paxman & Co., of Colchester, while the actual lighting of the buildings has been placed in the hands of five well-known firms. Messrs. Galloway and Sons, of Manchester, take the place of Messrs. Siemens Brothers as contractors for the garden lighting. Sir Francis Bolton will again preside, from the clock tower, over the fountains, from which novel features may be expected. On entering the buildings in the evening, one will miss the myriads of little star-like lamps which formerly met the gaze in the southern galleries, and will find in their place fewer but more powerful arc lamps. The whole of the electric lighting is under the superintendence of a committee, appointed by the Executive President, of which Sir Frederick Abel is chairman.

American National Electric Light Association.—This association, which was formed last year, commenced this year's convention at Baltimore, on the 10th inst., when the following programme of the work of the convention was promulgated :—Report of the Executive Committee on Credentials; naming of those who are entitled to seats in the convention, giving separate lists of the active and associate members. Papers: "History and progress of Electric Lighting," by Geo. Worthington, of New York; "Electricity as an Illuminant," Geo. S. Bowen, of Elgin, Ill.; "Arc Lighting," by Wm. Hochhausen, of New York; "Incandescent Lighting," by Dr. O. Moses, of New York; "Storage Batteries," by Prof. George Benjamin, of New York; "Use of Electricity in Lighthouses," Major Heap, Washington, D.C.; "Best Equipment for Arc Lighting Stations," D. E. Evans, Baltimore; "Underground Wires," by Ralph W. Pope, of New York; "Steam Power," by F. Fosdick, of Fitchburg, Mass.; "Operating Expenses," by E. R. Weeks, of Kansas City; "Relation of Electric Lighting to Insurance," by C. J. H. Woodbury, of Boston, Mass.; "Proper Construction and Maintenance of Circuits," by E. R. Weeks, of Kansas City; "Carbons and Globes," by Frank Ridlon, of Boston, Mass.; "History and Progress of Electricity, as applied to Motors," by W. J. Johnson, of New York; Report of Conference Committee on Uniformity of Prices for Apparatus in Service, by Frank Ridlon, of Boston, Mass.; Annual Election of Officers; Resolution fixing the place of the semi-annual meeting.

The Thomson-Houston Electric Lighting System.—The Thomson-Houston Company has orders for the following plants :—Worcester, Ohio, 30 lights; Waterbury, Conn., 30 lights (increase) for the Connecticut District Telegraph and Electric Company; La Fayette, Ind., Gas Light Company, 30 lights; Sheldons and Sons, Marble Workers, Rutland, Vt., 45 lights; Northampton, Mass., 30 lights; Aqueduct, New York, 30 lights, increase, making the eleventh machine installed there; Wilmington, N.C., 25 lights; Durham, N.C., 50 lights; Woonsocket, R.I., 38 lights increase.

Electric Lighting at Kimberley.—The Mayor of Kimberley prepared a lengthy minute of the proceedings of the past year, and recently presented it to the Town Council, Respecting the electric light department, he said : "A sum of £2,000 has been expended in this department on additional plant and improvement of old plant, enabling the service to be extended by another 14 lamps and at very little extra cost for maintenance. Proposals have been made to light up the railway station by this department, but as yet no satisfactory reply has been received from Government on this subject. The system of private lighting on the incandescent principle has already been discussed by the Council, the adoption of which would, no doubt, prove a source of revenue. I think I am safe in saying that this is the only town in South Africa the streets of which are lit by electricity."

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Economy of Electric Lighting.—The Boston, U.S., Post Office, it is stated, saved $10,000 last year by the use of the incandescent light instead of gas.

The Telephone on a Steamboat.—A telephone has been placed on board the steamer *Monohansett*. The wire is along the wharf at New Bedford, Mass., and connected with an instrument in the office. As the steamer leaves the wharf the wire is automatically detatched. This is said to be the first telephone ever put into a steamboat.

American Telephone Patent Litigation.—A dispatch from Washington, dated February 4th, states that the House Committee on Expenditures in the Department of Justice, agreed upon a resolution calling upon the Secretaries of the Treasury and the Interior and the Attorney General for information as to the amount of money, if any, which had been expended by the Government in the telephone cases recently before the Interior Department. Solicitor-General Goode is now engaged in the preparation of a bill to be filed against the American Bell Telephone Company, to vacate and annul its patent. He says that the suit will be instituted as soon as the papers can be prepared, and that no decision will be reached in regard to the place of bringing it until all the papers are ready.

Recent revelations in the *New York World* respecting the Pan-Electric Telephone Company, with which Attorney-General Garland is officially connected, show that the official influence of its leading members was mainly relied upon to make its stock valuable. It is said that the Government cannot conduct the litigation for less than $200,000.

Limitation of Telephone Dividends.—The Edinburgh Chamber of Commerce met last week and adopted a motion by Mr. R. A. Macfie, of Dreghorn—"That the directors take measures, in concert with other chambers of commerce, to see that the interests of the public were safe-guarded in any arrangements that might be made throughout the country with the National Telephone Company." Mr. Macfie thought it was reasonable that the dividends of the company should be limited, say, to 10 per cent.

The Plymouth Telephone Exchange.—Some interesting statistics have been published with reference to the progress of the "Three Towns Telephone Exchange," which has its headquarters at Plymouth. During the twelve months ending December 31st last, it is computed that no less than 18,860 calls were received, each conversation lasting on an average about two or three minutes. Thus, 56,580 minutes, or 40 actual days were occupied in these conversations. It being a well known fact that 100 words a minute can be safely spoken through the telephone, the estimated number of words spoken through the telephone, during the period referred to was, on this calculation, 5,658,000; and this not taking into account conversations between subscribers and operators, estimated at 653,280 words. Of course, every additional subscriber makes a difference to the number of calls. There is an increase of 90 subscribers on the previous year. During the last month, there have been 4,380 calls, but notwithstanding the severity of the weather of late, complaints have only been received in eight cases. There is still great scope for the development of the telephone in the Three Towns, and during the present year, the roll of subscribers may be expected to receive considerable augmentation from those tradesmen who as have yet ignored the great assistance to commerce which the telephone undoubtedly is. The fact is, people have scarcely yet got used to the telephone, with its innumerable advantages, being within their reach, but its merits are being so well advanced and advertised in the West, that a change must soon come o'er "the spirit of the dream."

Overhead Telephone Wires.—A correspondent writes to the *Times* :—"A circular of the United Telephone Company is going the round urging London solicitors to become subscribers to a telephone system proposed to be established in the new Law Courts, and offering to run wires thereto from each subscriber's office; 260 solicitors already use the telephone, and if the number increases it may be that in self-defence the whole legal community of 4,000 will feel compelled to substitute air messages for postal ones. In this state of things it is to be hoped that Parliament will at last step in. The report of the Select Committee of last year on telephone wires, as drafted by the Chairman, Mr. George Russell, specified, as he lately informed you, certain precautions as necessary in order to render safe the continuance of overhead wires. His draft report, which was not accepted, differed mainly from that of the majority of his committee in distinguishing between the rights to be accorded to the Postmaster-General and to private companies and others; the accepted report made no such distinction, but recommended that both should alike have power to pass wires over private property without consent of owner or occupier. The difference, as will readily be seen, is a vital one. The present growth of overhead wires is due not to the postal authorities, but to the telephone and other private companies, who, although paying a large royalty to the Postmaster-General, are not in any way subject to his control. It has been stated that the Postmaster-General has of late reduced his overhead wires by one-third, proving that he, at all events, does not favour the overhead plan. The fact of the crowded condition of subterranean London, especially in the City, not to speak of the expenses involved in interfering with asphalte and wood roads, or of consents required from road authorities, is sufficient doubtless to deter private companies from spontaneously following the lead of the Post Office. Pressure should, however, be brought to bear upon them, and the course which such pressure should take is, it is suggested, for Parliament at once to stop all further overhead wire-works by any person or company not specially authorised. The effect of this would be to drive the telephone companies into seeking Parliamentary powers, when Parliament would doubtless take care to impose conditions protective both of private rights and of the public safety."

Telephone Extension in Fifeshire.—The National Telephone Company is taking active steps towards establishing telephone exchanges in the various towns throughout the Kirkcaldy district. Already sufficient support has been obtained in Stirling and Alloa to enable them to make a start, and a connection will be made also with Glasgow. The company is at present soliciting support in Dunfermline, and should it be successful, connection will be made from there to Stirling on the one hand, and to Burntisland and Kirkcaldy on the other. Kirkcaldy will then be in direct communication with Glasgow, which will be of immense utility. An extension of the system to Cupar-Fife, St. Andrews, and Dundee, is also proposed, and efforts will shortly be made to obtain the necessary support.

Lecture on the Telephone.—Mr. Townsend, district manager of the National Telephone Company for Fifeshire, last week delivered a lecture on "The telephone in its history and applications" before the members of the Kirkcaldy Naturalists' Society, and was listened to with great interest.

Delivery of Telegrams.—In answer to Mr. Forwood, in the House of Commons on Monday, Mr. H. Fowler said it had been discovered at the Post Office that an address which might be sufficient for a letter might be insufficient for a telegram. Insufficiently addressed letters were intrusted to postmen familiar with the names of residents in their district, whereas the same

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information was not possessed by telegraph messengers. What was required was an address which should enable the messenger to deliver the telegram even without the name of the person to whom it was sent. If the hon. member would furnish him with the particulars of grievance he would see that the matter should be investigated.

Telegraphic Revenue.—The receipts on the telegraph service from April 1st, 1885, to February 20th, 1886, amounted to £1,535,000, against £1,550,000 received from April 1st, 1884, to February 21st, 1885.

Girls in the Telegraph Service.—"Dogberry," who writes in the *City Press*, makes the following statement :—The question is often asked, What shall we do with our girls ? It may be interesting to parents to know that at a recent preliminary examination of telegraph girls—60 being wanted—1,200 presented themselves. I understand these telegraphists get 12s. a-week to commence, and an increase of a shilling a-year.

Military Telegraphists' Dinner.—The non-commissioned officers of the 2nd division, telegraph battalion, Royal Engineers, met at dinner on February 5th, the 16th anniversary of the transfer of the telegraphs to the State, and subsequently passed a pleasant evening in song and speech. Major-General Webber, Mr. C. H. B. Patey, Mr. W. H. Preece, Mr. E. Graves, Lieut.-Colonel du Plat Taylor, and other gentlemen were amongst the visitors.

Proposed New Postal Telegraph Offices at Southampton.—At the last meeting of the Southampton Town Council, Mr. Lankester gave notice that at the next meeting he should move a resolution to the effect that the council should memorialise H.M. Board of Works that in connection with the new buildings now being erected at the back of the Post Office in the High Street, they should cause to be erected a building of such architectural character as would make the post office one of the most important buildings in the town, and be suitable to the importance of the borough.

A New System of Telegraphing To and From Moving Trains.—For several months past Mr. Edison, in connection with Mr. E. T. Gilliland, has been engaged in improving and elaborating the original idea of Mr. W. Wiley Smith, who proposed to communicate with moving trains by means of static induction between the metal roof of the cars and a telegraph wire, running parallel with the road. A section of the Staten Island Railroad, 13 miles in length, has recently been equipped on this system, and a first public test, a week or so ago, is said to have been in every way successful. Many messages were sent to and from the train while in motion, and with an ease and speed which left nothing to be desired. The representative of the *Electrical World* sent to his office from the moving train a message, which was received without any delay. The apparatus, both on the train and at the station, consists of the ordinary Morse key, a telephone as a receiver, and an induction coil for charging the wire and roofs of the cars respectively. A vibrating reed, or buzzer, in the circuit, gives a continuous musical note in the telephone, which is broken into dots and dashes by the closing of the Morse key. In this system the metal roofs of the cars are used without any alteration, and the ordinary telegraph wire upon the poles is employed. The Railway Telegraph and Telephone Company is operating the system, with which it intends shortly to equip several railway lines.

The Patent Laws.—The Committee appointed by the President of the Board of Trade to enquire into the duties of the Patent Office under the Patents, Designs, and Trade Marks Act, 1883, will consist of the Earl of Crawford and Balcarres, Baron Henry de Worms, M.P., Sir Bernhard Samuelson, M.P., Sir Richard Webster, Q.C., M.P., and Mr. Acland, M.P.

"Dynamo Electric Machinery."—In our article on this subject in last week's issue, by some unaccountable means an error crept into a sentence relating to the temperature of the dynamo which was not present when the last proofs were read. The sentence in question, which is on the lower part of the first column on page 157, should read : "There is no reason why the large dynamo should be worked at a higher temperature than the smaller one, and instead of the current being n^3 it ought to be less than n^2, really $n^{\frac{3}{2}}$," &c., the index of n in the last instance having disappeared in our last week's issue. In another part of the article we speak of the "horizontal component of the earth's magnetic intensity," whereas it should be the "vertical component," Thompson placing the armature horizontally with the axis in the magnetic meridian, the E.M.F. produced, therefore being due to the *vertical* component only.

Addresses of Patentees.—The correspondent who desires to learn the addresses of the applicants for the New Patents announced by us each week, will find what he wants in the *Official Journal of the Patent Office*, which is published twice weekly at the Patent Office publishing department in Cursitor Street.

The Science of Electricity.—At the last meeting of the Portsmouth and Gosport Natural Science Society, the president (General Drayson) in the chair, Mr. Sandy, the local manager of the Western Counties and South Wales Telephone Company, read an interesting paper on the history and progress of the science of electricity. Mr. Stelling, in moving a vote of thanks to the essayist, gave some interesting details of the experiments of Sir Charles Wheatstone, a relative of his, which led to the development of the telephone.

Volk's Electric Railway at Brighton.—The report of the Watch Committee on a letter received by them from Councillor Challis, asking why Volk's electric railway car was not rendered amenable to the bye-laws in the same way as any other public conveyance, was submitted to the last meeting of the Brighton Town Council, when the reply of the Town Clerk that the car in question did not require a license was endorsed.

Multum in Parvo!—In our last issue we notified the registration of Hirsh, Greystock & Co., Limited, with a capital of £50,000, for the purpose of purchasing the business of Walter Moser, portable electric light manufacturer, trading under the above appellation. The following advertisement, ruthlessly torn from a daily paper, contains some startling, yet discreet, announcements :—

"Electric Light Simply Marvellous. One Farthing per Hour.

"The Portable Electric Light gives a White Incandescent Light of many Candles, and Burns for about Three Hours without re-charging, which a child can do.

"The Portable Electric Light. No Danger, No Heat, nor anything unpleasant.

"The Portable Electric Light. Size 5 inches square. The price complete is only 30s. Order early.

"P.O. or cheque to be sent to Hirsh, Greystock & Co., Limited, Electric Lighting Contractors by Primary Batteries for Domestic Lighting, &c., 11, Queen Victoria Street, London, E.C."

It will be noticed that the candle-power per farthing hour is left to the reader's own estimation—a wise proceeding. The child which is father to the man is generally looked upon as being somewhat precocious, but what shall be said of the child which can burn for about three hours without re-charging ? It is to be feared that Messrs. Hirsh, Greystock & Co., have not selected a very opportune moment for the disposal of their wares, for in these days of trade depression we imagine that but few will be found who will not consider twice before investing their 30s., be the bait never so temptingly prepared.

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Primary Battery Rights.—Mr. Charles S. Stewart asks us to contradict the report that he has sold his primary battery rights to Messrs. Grant Bros., of High Holborn.

The Glasgow Philosophical Society.—At a meeting of the Glasgow Philosophical Society last week, Mr. Joseph W. Swan, inventor of the Swan electric light, read a paper on "An Electric Safety Lamp for the Use of Miners, &c." Mr. Swan directed attention to the great simplicity and power of the combination of zinc and peroxide of lead, which he had made use of in the primary battery. It was a combination proposed by De la Rive nearly forty years ago, and had been entirely neglected. The electromotive force was 2½ volts, only one liquid was used, and that not a primary one (dilute sulphuric acid), and the exhausted peroxide poles could be re-oxydised by means of the dynamo at a very small cost. In reply to a question at the close, Mr. Swan said he was not yet able to state what would be the cost of such lamps, but the cost of maintaining them would not be greater than the cost of the lamps at present in use—viz., about 4d. a week.

A paper on "Direct-reading Galvanometer for Strong Currents" was read to the meeting by Prof. Blyth. He described a modification of the current weigher, by means of which the strength of an electric current could be determined by calculation alone. It consisted of two circles of wire placed, with their planes horizontal and parallel, at a known distance apart, and so attached to an ordinary chemical balance that the repulsion between the wires, when each carried the same current, could be accurately determined in grammes. From this weight, and the diameter and distance apart of the coils, it was shown how the current strength could be accurately ascertained. It was stated that this method of measuring a current was free from the errors incident to the various forms of tangent and sine galvanometers, which equations involved as a factor the horizontal intensity of the earth's magnetism, which was a very variable quantity, and difficult to measure exactly. The Professor then described a new form of galvanometer for the measurement of strong currents. The peculiarity of this instrument was that its indications are directly proportional to the current strength through all ranges. By adjusting the length and thickness of a torsion wire it was shown that the instrument could be made to read either ampères per degree or per two degrees, as might be desired. A modification of the instrument was also explained, in which the deflections were proportional to the square of the current strength.

Discovered at Last.—First Kentucky Colonel: "I see that a man in Pennsylvania has made a great discovery."—Second Kentucky Colonel: "Ah, what is it?" "He thinks he can decompose water and produce an excellent illuminant." "Is that so? Well, do you know I always expected that some use would finally be found for water."

Charging Secondary Batteries.—Is Professor George Forbes correct in his assertion that secondary batteries are best charged in parallel? If he could ensure the resistance of all the cells to be perfectly alike, the method might be feasible; but, if we are not mistaken, the manufacturers of these batteries do not adopt the course advised by Mr. Forbes.

The Cowles Electric Furnace.—We bring before our readers this week the very interesting subject of the Cowles electric furnace, employed in the United States for the production of aluminum and its alloys. Hitherto, we believe, this apparatus has been but briefly touched upon by the technical journals in this country.

Removal.—Messrs. G. Binswanger & Co., manufacturers and patentees of electrical apparatus and insulating material, have removed from 29, Aldermanbury to 5, Great St. Thomas Apostle, Queen Street.

Secondary Batteries.—In an article upon secondary batteries, the *Electrical Engineer* says: "According to the patents of FitzGerald and his colleagues, no grid or supporting frame is required, the electrode being made of finely-divided lead pressed into flat thin cakes, a system developed in the various patents of Mr. Desmond FitzGerald, who has, if reports be true, made the greatest step of all, namely, the production of a conducting peroxide plate or electrode, not supported by a grid, and the efficiency of which is said to leave all others far behind in every respect. We are told that a battery made under Mr. FitzGerald's recent patents has been tested in Paris, and a report written thereon by M. Hospitallier. This is said to be highly favourable in every way, but it seems curious that the proprietors should prefer to show the battery first in France, and have it first reported upon by a French *savant*, instead of showing it first in England. Mr. FitzGerald is known to have done some of the most important work in the invention and development of secondary batteries, but by some unfortunate combination of circumstances the results of his work seem to be locked up by him or by those to whom the patents belong, and this is the case with other important inventions by the same electrician. The patents of Mr. FitzGerald and his colleagues are those which originated the employment of finely divided lead or oxides, moulded or pressed into flat cakes, and it seems strange that batteries constructed on their system should not yet, as far as we are aware, be in the market."

Electrical Fire Alarms.—On the evening of the 23rd inst. Mr. W. L. Carpenter, manager of the School of Electrical Engineering, Princes Street, Hanover Square, made an interesting contribution to the weekly series of Penny Science Lectures in progress at the Victoria Hall and Coffee Tavern. The subject was that of American electrical fire alarms. In Boston and elsewhere, at the central fire-office, so perfect and ingenious were the arrangements that the same current of electricity which gave the alarm also opened the doors of the stables and released the horses from their tethering. The horses were then trained to place themselves in position on either side of the shafts of the fire-engine, they were harnessed with self-adjusting "snap" harness, and literally within six seconds of the first alarm the engine was on its way to the scene of danger. In asserting this, he was strictly narrating what he had seen and checked for himself, watch in hand, and of the truth of what he had said he gave his word of honour. He had been privileged to signal the alarm himself to a station one mile distant, and the horses came galloping up to the spot exactly four-and-a-half minutes afterwards. At the central offices of the Salvage Corps, too, wonderful things were done in the way of alacrity. Here the men slept in their under garments, and upon the bed were their trousers, which were sewn inside their boots. The bedclothes were attached to a wire, and at the first alarm were violently pulled off. At the same time a trap opened in the floor, and the men, while putting on their trousers, slid down an inclined plane into a vehicle below. Altogether it took them 13½ seconds to get out of the building fully equipped. Mr. Carpenter also described the self-acting fire alarms, which send a warning message directly the apparatus gets heated, and he pointed out that a practical testimony to their value lay in the fact that factories which employed them were insured by the fire offices at from one-half to one-third of the ordinary rates. The lecture was illustrated by lantern photographs and by experiments, all of which were projected on the screen.

Fire at a Telegraph Works.—We noticed the following in the *Evening Standard* of Saturday last:—An explosion occurred to-day at Siemens's telegraph factory, at Charlton, setting fire to the premises. The fire raged for 20 minutes, and was not extinguished before considerable damage was done. The cause of the explosion is unknown.

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Soirée at University College.—On the evening of Wednesday, February 17th, Prof. A. B. W. Kennedy and the Committee of the Engineering Society held a most successful *soirée* at University College, London, in connection with the College Society. The Electric Apparatus Company and Messrs. Woodhouse and Rawson both gave electrical exhibits, which proved very popular. The College Society organised a show of photographs and photographic apparatus in the Library, where Messrs. Clarke & Clarke exhibited their method of printing by gaslight. They also gave a concert in the Botanical Theatre, the music being, through the kindness of the United Telephone Company, transmitted to a distant room. The *soirée* was attended by about 1,000 visitors.

Goolden and Trotter's Dioptric Glass Shades.—Among the glass shades supplied from Portsmouth for the installation on board H.M.S. *Devastation*, there were a dozen of the above, issued for comparison with the ordinary ground glass shades, and so greatly were the Trotter shades preferred, that the 12 were speedily appropriated for the officers' cabins. A similar issue is being made to all ships using the electric light, in order that a full report may be made as to their merits.

The Distribution of Electricity.—We may remind our readers that the Cantor lectures to which Prof. George Forbes refers in his paper, "Some Points in Electrical Distribution," were reported *in extenso* and illustrated in the columns of the ELECTRICAL REVIEW at the time of their delivery, viz., in the issues for February 7th, February 14th, and February 21st, 1885.

Pneumatic Propulsion.—Mr. Moon shows very clearly how uneconomical is the use of pneumatic tubes as a means of conveyance. The same thing was pointed out many years ago by the late Robert Sabine in an exhaustive report made by him upon the subject.

Nordenfeldt's Submarine Boat.—For full particulars of how this vessel behaves in action, together with a description of the electric shrimp torpedo and the self-acting telephone *vide Punch* of last Wednesday.

Conversazione.—A *conversazione* in connection with the Bradford Philosophical Society was held in the Technical College, Bradford, on the 10th instant. There was a large display of scientific apparatus, those having special reference to electricity being a collection of galvanometers, voltmeters and other apparatus from the Yorkshire College, Leeds. Two interesting cases were exhibited by Mr. Brodie, local agent of the Silvertown India Rubber, Gutta Percha and Telegraph Works Company. One contained shore-end and deep-sea cables, and the other showed India rubber in different stages of its manufacture. During the evening popular science demonstrations were given in the different lecture rooms. The Rev. J. R. Rendell, Yorkshire College, explained the recent researches by Prof. Hughes on the self-induction of an electric current, a set of apparatus similar to that used by Prof. Hughes in his lecture before the Society of Telegraph Engineers being shown. The elongation of a piece of soft iron during the time that a current of electricity is passing around it was also made clear to the audience by means of the movement of the ray of light upon the screen.

"Oh! Woodman Spare that Tree."—The *South Australian Advertiser* states that Lieutenant Immergosende (of the German Navy) and Dr. Kummel have explored North-East Guinea. They report that they reached a spot 12 days' march from the coast, and discovered that their compass was useless, owing to the presence of a tree which possesses the properties of a highly-charged electrical battery. Dr. Kummel was knocked down when he touched it. Analysis showed it to consist of almost pure amorphous carbon. It has been named Elsassia Electrica.

Complaints against the Blackpool Tramway.—*Gas and Water*, in a recent issue, says:—"Complaints against gas companies, both on account of smoke and smells, are less common than they were some years ago, the reason being that in these days every care is exercised to remove objections to the process of gas manufacture. The tables are now being completely turned. Gas companies instead of standing in the place of the accused are entering the lists as complainers against the smoke nuisance. An instance of this kind has just occurred at Blackpool. The gasworks property in that fashionable watering place appears to have been damaged by "black smoke" proceeding from the chimney belonging to the Blackpool Electric Tramway Company, and the town clerk has been instructed by the council to call the attention of the company to the nuisance. When the subject was under discussion on Tuesday it transpired that formerly there had been numerous complaints about the smoke from the electric light engines, but the smoke from the tramways furnace had proved a greater nuisance. Settling down upon all newly painted surfaces, the soot completely neutralised the efforts of the gas manager to give a clean and tidy appearance to the works. Let us trust the nuisance will be removed. It would not be very seemly to find the providers of gas and electricity in a court of law on a question of this kind." We quite concur in the closing sentiment of our contemporary.

Steam Engine Tests.—The journal of the Franklin Institute for the present month contains the report of the examiners upon the steam engines which were shown in the late Electrical Exhibition in Philadelphia. As none of the exhibitors made application for a competitive test as prescribed under the code, all tests are quantitative; and, for various reasons, the committee submits the report without any expression of opinion. The engines tried were the "Porter-Allen," the "Buckeye," and the "Southwark."

Gas v. Electricity.—At the annual meeting of the Midland Gas Managers' Association, held in Birmingham, the President, in referring to the future prospects of gas companies, said that he did not pretend that gas had nothing to fear from the electric light. With so many able men and busy brains at work on the subject, gas lighting might yet experience trouble from electricity; but there was no need for them to be afraid of it. He still believed gas property to be one of the safest of investments.

Electric Lighting of the Folkestone Exhibition.—The lighting of this exhibition, which it is intended to open on May 1st, has been entrusted to the Electrical Power Storage Company. It is proposed to employ arc lights for the central nave, refreshment rooms, and gardens; and incandescent lamps for the picture galleries. There will be in all 36 arc lamps of 3,000 candle-power, and 1,250 incandescent lamps. The dynamos and arc lamps used will be those of Messrs. R. E. Crompton & Co., and the engines will be supplied by Messrs. Marshall, Sons & Co., of Gainsborough; a set of E.P.S. batteries being used on each circuit, to act as regulators, and guard against the possibility of a total extinction of the lights.

At the meeting of the Anglo-American Brush Corporation, a report of which was published in our issue of the 12th inst., it was stated that the Corporation had the order for lighting this exhibition. Is not this a case of counting one's chickens, &c?

Telephonic Experiments Abroad.—The correspondent of the *Standard*, telegraphing on Wednesday night from Vienna, says:—"The telephone trials between Brünn and Vienna, which commenced yesterday, were continued to-day, and have proved completely successful. The ordinary telegraph wire was used, without interruption of the service, and the words were not only audible, but the speaker's voice could be distinguished."

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Electric Lighting in the Navy.—The work of fitting H.M.S. *Mersey*, at Chatham, with the electric light, which is being carried out by Messrs. Goolden and Trotter, under the superintendence of Mr. R. A. Scott, was commenced last week.

A trial has just been made at Portsmouth of an installation of the electric light, which has been fitted on board the *Impérieuse* by Messrs. Siemens Brothers and Company, who are also about to provide similar installations on board the *Warspite*, *Edinburgh*, *Collingwood*, and *Rodney*. The lights on board the *Impérieuse* comprise 375 incandescent lamps of 20-candle power, which are disposed so as to illuminate all parts of the ship including the engine-rooms, stokeholes, and magazines; and also a couple of search arc lights, placed at the bows and at the stern, and which are each equal to the power of 25,000 candles. The currents are generated by three Siemens's dynamos, on the combined and self-regulating principle, each of which is driven by one of Willans' compound two-cylinder engines, which is fixed to the same bedplate as the machine which it drives. The number of revolutions per minute is 400. The machines are interchangeable, and can be connected or thrown out of action by a simple switch arrangement. One of the machines supplies the search lights, and another is equal to maintaining 320 of the incandescent lamps aglow, which is considered as many as will be necessary as a rule to be alight at the same time. When the whole of the incandescent lamps are required to be lighted at the same time two dynamos will be demanded for the several leads, otherwise one will be kept as a reserve against accidents. The arrangements have been superintended on behalf of the company by Mr. Collings, and the preliminary trial during the day and after dark proved very satisfactory.

Telegraphic and Telephonic Communication.—At the meeting of the Associated Chambers of Commerce at the Westminster Town Hall, on Wednesday, the question of telephonic communication was discussed, and it was decided to request the Government to withdraw the monopoly they claimed in regard to telephones. There were four propositions upon the business paper with reference to the registration of telegraphic addresses; but these were concentrated in a proposal of the Southampton and Middlesbrough Chambers expressing the desirability of a considerable reduction of the registration of one guinea, and of the publication in the principal commercial centres of official lists of the registered addresses, and the firms using them. This was agreed to.

Domestic Electric Lighting.—We had hoped to be able to present our readers this week with a description of the electric lighting installation at Broomhill, Tunbridge Wells, the residence of Sir David Salomons, Bart. Pressure on our space, however, compels us to hold this over.

Direct and Counter Electromotive Forces.—We have received a paper reprinted from the American *Journal of Science* on "The Relation between Direct and Counter Electromotive Forces represented by an Hyperbola," by Prof. H. S. Carhart.

The Telephone.—The growth of the telephone (says the Boston, U.S., *Transcript*) is one of the most remarkable in the history of inventions. In August, 1877, the number of instruments in use in this country was only 780, while in February, 1880, there were 60,800, 249,700 in 1883, 307,010 in 1884, and in February, 1885, 325,574. There are about 18,000 in Canada, and 13,000 in Great Britain. The number of exchanges has grown from 100 in 1880 to 782 in 1885. In January last there were 137,223 miles of telephone wire in this country. There are 5,186 persons furnished employment by the exchanges. More different patents have been issued on the telephone than in any other single line of invention in this country. The total number for the ten years is 1,521.

Indian Telegraph Department.—Mr. Conybeare asked the Under Secretary for India, on Monday, whether it was the fact that the complaints of the officers of the Telegraph Department in the Government of India in respect of absence of promotion had been long admitted by the Government of India to be well-founded; whether any and what steps had been or were about to be taken to remedy their grievances; and whether he would communicate with the Government of India with a view of laying before Parliament at an early date all the papers relating to the subject. Sir U. Kay-Shuttleworth replied that the fact that there were grounds for complaint had been admitted, and was the subject of correspondence with the Government of India, with the hope of increasing the efficiency of the department and for remedying all just grievances. As soon as possible information would be given to Parliament.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Fischer Electro-Amalgamator Company, Limited.—An agreement, dated 8th inst. and filed on the 18th inst., confirms a preliminary contract of 9th September, 1885, for the purchase of certain patent rights from Mr. Max Wm. Weber, and authorises the issue to Messrs. J. Pearson Benwell and M. W. Weber of 1,500 fully paid shares.

Maxim-Weston Electric Light Company, Limited.—An Order of Chancery Division of the High Court of Justice, dated 6th inst. and filed on the 15th, authorises the reduction of the capital of this company in accordance with the resolutions passed and confirmed at the special meetings held on the 15th ult. and 1st inst.

Atlas Electric Appliances Company, Limited.—The annual return of this company, made up to the 15th inst., was filed on the 22nd inst. The nominal capital is £2,000 in £1 shares. 707 shares have been taken up and the full amount has been called and paid thereon.

Laing Electric Light and Power Company, Limited.—The annual return of this company, made up to the 15th inst., was filed on the 22nd inst. The nominal capital is £1,000,000 in 100,000 shares of £10 each. 12,007 shares have been taken up and the full amount has been called and paid thereon.

Hirsh, Greystock and Company, Limited (electricians).—The registered office of this company is at 11, Queen Victoria Street.

Railway Electrical Contractors, Limited.—Under an agreement of 29th October, 1885, filed on the 12th inst., Major Strutt, of 144, Leadenhall Street, is appointed managing director of the company, at a salary of £100 per annum and a commission of 10 per cent. on the net profits. The services of Mr. C. E. Houghton are retained as consulting electrical engineer, at a fee of ten guineas for each train fitted and lighted, or at such other fees as may be mutually agreed upon. A suitable assistant electrical engineer will be appointed, at a salary not exceeding £200 per annum, such engagement to be made by Major Strutt, subject to the control of the board. In order to provide working capital for carrying on and extending the business, the company agree to issue £5,000 of debentures at 6 per cent. per annum, or 1,000 7½ per cent. preference shares of £5 each. On any such issue, Major Strutt will have the option for six months from the date of the allotment, to take £1,250 or any less amount thereof at par. Major Strutt will, as soon as a resolution is passed authorising the issue of shares at a discount, pay to the company the sum of £500, and in consideration thereof and of services rendered, the company will issue to him the remaining 750 ordinary shares of the company as fully paid up.

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NEW COMPANY REGISTERED.

J. E. H. Andrew & Co., Limited.—Capital £30,000 in £20 shares. Objects: To take over the goodwill and business of J. E. H. Andrew & Co., and to manufacture, buy, sell and deal in gas and electrical engines and motors and all apparatus used in connection therewith. Signatories (with one share each): * C. H. Andrew, Mrs. E. H. Andrew, and * Hugh Williams, C.E., of Stockport, Cheshire; * H. H. Andrew, J. A. A. Andrew, and T. Nicholson, of Sheffield; and E. Robinson Walker, of Manchester. Directing qualification, £1,000 in shares or stock. The signatories whose names are preceded by an asterisk are the first directors. The company in general meeting will determine the remuneration of the board. Registered 20th inst. by Waterlow Brothers and Layton, Birchin Lane, E.C.

LEGAL.

The United Telephone Company v. Bassano and Slater.—In the Court of Appeal, before Lords Justices Cotton, Bowen, and Fry, on Wednesday, an application was made by the plaintiffs to dismiss for want of prosecution an appeal presented by the defendants from the judgment of Mr. Justice North, on August 12th last, restraining the defendants from infringing the plaintiffs' patent of July 30th, 1877, for the Edison transmitter for telephones. The trial of the action in July last was fully reported in the Review. On the 12th of August Mr. Justice North gave judgment as above stated, and also ordered the defendants to deliver up certain instruments which were in their possession. The learned Judge, however, postponed stating his reasons for his judgment, and he has not yet stated them. On September 23rd last, the defendants served notice of appeal. On December 4th a receiving order in bankruptcy was made against the defendants on their own petition, and in consequence of this the appeal could not be brought on in its proper turn. The plaintiffs, on the 19th inst., gave notice of motion that the appeal might be dismissed for want of prosecution. Mr. Ashton, Q.C., and Mr. Micklem, for the plaintiffs, now moved accordingly. Mr. Claude Plumptre, for the bankrupts and the Official Receiver, urged that until the learned Judge had stated his reasons for his judgment it was impossible for the Official Receiver or the bankrupts to be properly advised as to the prosecution of the appeal. The Official Receiver would have a *locus standi* by reason of the order for the delivery up of the instruments. Lord Justice Cotton said that the application was of a somewhat novel character. If the Official Receiver was carrying on the business of the bankrupts he would be interested in the injunction. And, notwithstanding the bankruptcy, the bankrupts were also interested in it, because it prevented them from carrying on their business by the work of their own hands, and if they committed a breach of it they would be liable to be sent to prison. The Court had ascertained from Mr. Justice North that he would state his reasons within a short time, and they thought that the proper order to make would be this—that if the bankrupts did not within a fortnight after Mr. Justice North had stated his reasons give security to the amount of £100 for the costs of the appeal, or the Official Receiver did not within the same time make himself a party to the action, the appeal should, without any further order, be dismissed without costs. If within the fortnight the bankrupts should give the security, but the Official Receiver should not make himself a party, the appeal would proceed as that of the bankrupts alone. On the other hand, if within the fortnight the Official Receiver should make himself a party, but the bankrupts should not give the security, the appeal would proceed as that of the Official Receiver alone. Lords Justices Bowen and Fry concurred.

The United Telephone Company v. Waltermann and Co.—In the Chancery Division, before Vice-Chancellor Bacon, on Saturday, counsel moved, on behalf of the plaintiffs in the above action, for judgment against the defendants in default of their not having put in any defence. The statement of claim, he said, alleged that the defendants had infringed certain of the plaintiff company's patents, the validity of which had been impugned in previous litigation, when the question was decided in favour of the plaintiffs, and went on to ask for an injunction in the usual form, to have the infringing instruments delivered up, and to have an enquiry in chambers as to the matter of damages, together with the costs, charges, and expenses, as between solicitor and client, to be paid to the plaintiffs. The claim for an enquiry as to costs between solicitor and client was under section 31 of the Patent Act of 1883. The Vice-Chancellor granted judgment in the terms asked for.

CITY NOTES, REPORTS, MEETINGS, &c.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited.

The twenty-second ordinary general meeting of this company was held at the Cannon Street Hotel on Thursday, the 18th inst., for the purpose of receiving the directors' report, which has already appeared in the Review, and for other business. Mr. S.W. Silver, chairman, presided.

The notice convening the meeting having been read, and the report being taken as read,

The Chairman proceeded to move the adoption of the report, and, in doing so, said he thought he might allude to the occasion of their last meeting. It was a pleasure to meet, especially under such circumstances as they had the opportunity of doing that day. He then alluded to the issue of new shares, and he thought they might each congratulate themselves upon the result. The fact of the shareholders having supplied the board with the additional sinews of war would, in measure, account for the satisfactory state of things which, he hoped they felt with him, the board had the opportunity of putting before them that day. The operations of the year would, he was sure, bear comparison with any undertaking of a similar character. They must bear in mind that competition on all sides was so strong that their difficulty in getting orders was very great, and their difficulty in getting orders to leave anything like a margin of profit was still greater. Now, he did not think he need go into the question of figures, and detain them in doing so. These were a proof of the labours and the close attention on all sides to the interests of the company. They, he thought, showed very fairly as compared with previous years. The result of their net profits this year was within a very little of that of last year, leaving a disposable balance of £137,547, whieh, of course, included the premium upon the new shares, which, as they saw by their report, was passed to the reserve fund; so that after deducting a dividend of £41,600—that was £1 per share—they had a balance to carry forward of about the same amount as last year. As regarded work done, they had connected the Cape Verd Islands with the West Coast of Africa, and sold that cable to the Eastern and Brazilian companies. They had connected the Portuguese and French possessions on the Coast of Africa to the extent of 600 miles, and the remaining portion was in process of manufacture, and would be laid towards the close of the year, under a guarantee from the Portuguese of £42,000 and a subsidy from France of £12,000. Besides this, for the Government Indo-European Telegraph Department they had manufactured upwards of 500 miles; their steamers had conveyed the cable to the Persian Gulf, and that cable hadbeen laid most satisfactorily, their own people being present under the direction of Mr. Theophilus Smith. The whole of this operation had been referred to already in the *Times* of the 25th of last month. He alluded to it because it really gave a very satisfactory account of the whole proceedings, and they would agree with him they were not in the habit of blowing their own trumpet. They had in that a very satisfactory report of the manufacture of the cable, and of the employés connected with the India Rubber Company, and as to the state of the ships. They had several orders which they had executed for the Post Office, for the Western Union, for the India Office, and Western and Brazilian, so that they had been fairly occupied. With reference to the general state of the works, he might say electric lighting had not been overlooked by them. Should the time come for a general demand for that most delightful adjunct to their household, they were quite prepared to meet it, and that meant that their works were in very excellent order. They were in a position now, he might say, to complete an Atlantic cable under six months, and for their satisfaction he might tell them that the item of expenditure upon the works might be considered closed. It would not, he thought, be added to much further. Now, all this meant that much care and attention had been given by the manager, and by each member of their staff. That had not been brought about without a great deal of anxious and unceasing care and attention; and at once he was brought to the fact that he occupied the chair that day in the place of one whom to know was to respect. He fully endorsed the words that the report gave utterance to. He could add little to it but say that Mr. Geo. Henderson's attention was unceasing. In their anxiety to fill his place, they had persuaded his friend Mr. Gray to take a seat at the board. (Applause.) He was sure it would meet with their approval. In him they had, he might say, the lever, and to him might they attribute much of their success. Not only as regarded the works, the processes of manufacture, but also the selection of the employés, his judgment there had been proved again and again to be excellent. Their thanks were certainly due to the members of the staff, and he must not pass over his excellent friend, Mr. Hutchins, their solicitor, whose advice and counsel they had also great reason to be thankful for. Without further observations on his part, he did not think he ought to overlook the fact that in laying those cables, in the preparation for doing so, the soundings, and so on, Mr. Robt. Gray, Mr. Buchanan, and all others on board their steamers, had lost no opportunity of adding to the science of physical submarine geography. In Oxford the other day, in conversation with Prof. Moseley, whose name stood very high, he was glad to hear that the work was being fully recognised. With these observations, as they would have to refer to the special resolutions at the meeting that was about to take place, he would move, "That the report and accounts now presented be received and adopted, and

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that a dividend of £1 per share, free of income tax, payable on and after the 19th instant, be now declared."

Mr. N. Bannatyne (director) seconded the motion.

Mr. Dixey said, as a shareholder, he would like to say a word or two with regard to the particular paragraph to which the Chairman had alluded. He (the speaker) referred to the paragraph which informed them of the death of their late Chairman, after having been 20 years a director and Chairman amongst them. In two or three touching sentences they were told that his health gradually declined, that he quickly passed away, but not without giving to his colleagues the benefit of his experience and sober judgment; and as that was the first general meeting since his decease, he thought it would be only a fitting thing that some grateful tribute of respect to his memory should be paid. They thought that day of his familiar face, of his kind and courteous conduct whilst occupying the chair; of the manner in which he received questions, and the courteous way in which he answered those questions, often throwing considerable light upon them. They thought of the words which he spoke, which were altogether words of inspiration and strength to them as members of that company, and never more so than when it was in its least prosperous condition; and though the chair which he had vacated was worthily filled, he thought they could not part with their friend without a feeling of deep sympathy with those members of his family and friends with whom he was most closely associated in life. That being so, he would venture to present to them a resolution, and he trusted that it would not want a seconder. He would not occupy their time further, but simply read the resolution :—" That this meeting, having heard with sincere regret the paragraph in the report announcing the death of Mr. George Henderson, desires to express its high appreciation of his personal character and worth, the uniform courtesy and consideration which distinguished him as director and chairman for more than 20 years, the strenuous efforts made by him in the interests of the company, which have contributed so largely to its development and present success; and this meeting further desires to express its cordial sympathy with his colleagues, and requests that a special message of condolence may be conveyed, through the Secretary, to the widow and members of his family, with a copy of this resolution." He (the speaker) left it with the meeting.

Dr. Small said, although not always at one with the late Chairman, yet he rose with very great pleasure to second the resolution. His conduct was always courteous and kind, and he quite endorsed the remarks made in the report. In times of difficulty he lent his name, as the report said, making himself personally liable on behalf of the company. He thought they would be unanimous in adopting the resolution.

The motion was unanimously agreed to.

Mr. Sutcliffe said that, according to the articles of association, the directors were to receive 10 per cent. remuneration upon the profits, in addition to the sum of £2,000. Although the report they had had before them that day was very satisfactory and pleasing to every one of them—and he hoped the success of the company would continue—yet it seemed to be an excessive amount to devote to the directors year by year. The amount that the directors took, according to the balance-sheet before them that day, was £4,700, giving to each gentleman about £1,200; and he supposed that the managing director had probably some remuneration beside. That was not shown, but he presumed that it was shown in the amount for salaries and general expenses, £56,342. He would like to know himself whether the managing director had a separate salary for managing this concern in addition to the amount paid to him. He (Mr. Sutcliffe) remembered the time when that company was not in the flourishing condition it was in to-day, when the shares stood at a great discount. He was at that time a shareholder, and at one time sold out his shares, but, fortunately, he bought them back again in good time. It seemed to him that the amount they gave these gentlemen for managing that company was excessive.

Mr. Hanson said what the directors received was strictly in accordance with a resolution passed five years ago. If dividends were not kept up, then the directors were simply to receive so much: if the company was successful, then they received a certain advantage.

Mr. Cattlin asked at what value the various steamers stood on the books.

Mr. Cochran asked if anything was being done in carrying out the work which was authorised by the shareholders some years ago, of establishing a building at Silvertown for the benefit of the working people. He thought that there was a good deal to be done to lighten the difficulties under which the working people existed—crowded together to a very great extent. He remembered very well that the shareholders acquiesced in the proposal made by the directors, but he had been unable to learn that any steps had been taken to put the resolution in force. There was a great deal of overcrowding in the district, and he should be pleased to know that the work would soon be commenced.

The Secretary at this point read a resolution agreed to on the 9th February, 1881, at a general meeting of the shareholders, which was to the effect that the ordinary remuneration of the directors should be £2,000 per annum, and whenever the shareholders received a dividend of 10 per cent. or more, the directors be entitled to receive additional remuneration; but in no case should the directors' remuneration exceed £5,000.

Mr. Gray, at the request of the chairman, replying to a previous question, said that the value of the steamers in the books was 40 per cent. less than they cost the company. For instance, one ship which cost £115,000, stood at £50,000; and another, which cost 45,000, stood at £30,000; and another, which cost £32,000, stood at £20,000; so that he thought they were in a pretty healthy condition. In reference to the public hall, he quite endorsed the necessity for having that hall and the various class rooms put up. But there had been nothing done except that detailed drawings had been made out, and the land was ready to receive the buildings when they were in a position to commence operations. The reason they had not done so before, was because they had been so very busy in the erection of their own works, upon which all their attention was more immediately concentrated. They had by no means lost sight of the project that had been referred to, and he hoped the shareholders would allow the matter to remain where it was until their hands were free to get at it.

The report was then agreed to.

Mr. Henderson said he rose with a very full heart to thank them and his friend near him, for the kind—and they would allow him to say, affectionate—words that had fallen with reference to his father. He was sure that could he have been present personally, nothing would have given him greater pleasure or greater gratification than to know that his efforts for the company had been so highly appreciated. He would not detain them, but would simply beg to return, on behalf of his mother and other members of the family, their warmest and hearty thanks for the sympathetic words and the kind resolution they had just passed. (Applause.)

Mr. Scott said it fell to him to propose that Messrs. Silver and Bannatyne, who retired by rotation, be re-elected as directors of the company. Both gentlemen were very large shareholders. They had worked well for the company, and he did not think he could name any two men in London better fitted to hold such an office.

Mr. Gray said he had much pleasure in seconding the motion; and it was agreed to.

The Chairman, in reply, said that in the name of himself and his co-director he begged to thank the shareholders for that mark of their renewed confidence, and assured them that their best exertions should be devoted to the interests of the company.

Mr. Kelso moved, and Mr. Sinclair seconded, a proposition that Mr. John Weise be elected auditor of the company's accounts for the present year, with a fee of 30 guineas; and the business of the general meeting then concluded.

An extraordinary general meeting of the company was then held, for the purpose of proposing the annexed resolutions, Mr. Silver again presiding. After the notice convening the meeting had been read,

The Chairman proposed the first resolution, which was as follows :—"The board of directors may from time to time appoint one of their number, or any other person, to be a managing director of the company, and may determine the amount of his remuneration and the term of his engagement, but no such engagement shall be for a longer period than five years. A managing director shall not retire from office by rotation during the period of his engagement." He said it would at once strike those who had had, like himself, much to do with business transactions, that promptitude was very often an important feature, that the board could not sit continuously, and that the managing director, having a seat on the board, could act in the interests of the company when, perhaps, anything might arise. He did not think there was any more argument necessary on that occasion to be used, but he would mention that the carrying of that resolution would not involve any increased expenditure in the management.

Mr. Bannatyne seconded the resolution.

Mr. Hancock said they were not told what the amount per annum would be; whereupon,

Mr. Bevan suggested that it would be hardly expedient that a private arrangement by which the directors managed the concern so successfully and satisfactorily should be detailed too fully. Mr. Gray was known to them as a first-class man. He had had, as they knew, some opportunity of judging of Mr. Gray's vigour and energy, and he could testify to his extraordinary qualities. It was not expedient that the question should be raised.

Mr. Gray said, as he was the particular person concerned, he could them tell frankly he had not the slightest objection to state the terms. (Cries of "No!")

The Chairman said there was no additional cost likely to arise to the company out of this arrangement. On the contrary, he felt it his duty to say that Mr. Gray was making a sacrifice, and that that sacrifice would be to the benefit of the *employés* of the institution. He need not say more in asking them to express their opinion.

The motion was then carried *nem. con.*

The Chairman, in moving the second resolution—which ran thus: "The number of directors (including any managing director) shall not exceed seven nor be less than four, and every director shall hold at least 100 shares in his own name as the sole holder thereof. The directors may from time to time appoint any additional directors or director, provided the number of directors shall never exceed seven"—said that they found the work very hard, or had found it so; and they, therefore, asked the shareholders to strengthen their hands; and he had great pleasure in moving that resolution. At present holding was nominal, no alteration had been made for years past in the clause concerning shares, and they considered that the holding of each director should be not less than £1,000.

Mr. Bannatyne seconded the motion.

Mr. Hancock suggested that the number of directors be nine

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rather than seven. When that company was first started the number was 12; that number was reduced some years ago to five, and the directors had found that it was desirable to increase that number, and although the number seven would be a sufficient number for the regulations of the company—because he believed small boards worked better than large ones—still, at the same time, he thought they ought not to limit themselves too strictly. He thought they were exercising a wise discretion in keeping the number small.

The Chairman put the resolution to the meeting, and it was agreed to.

The Chairman then proposed, and Mr. Bannatyne seconded, the third resolution, as follows:—"The remuneration of the directors other than a managing director shall be from time to time determined by the members at the ordinary meeting; but any proposal for the alteration of the remuneration of directors shall be deemed special business, requiring seven days' notice to be given thereof."

Mr. Hancock said the question had been discussed at previous meetings, and it was decided that the remuneration henceforward be £2,000, and a further sum according to the profits of the company.

The Chairman said they did not propose to alter it.

Mr. Hancock, after some further remarks, said the directors should be satisfied with the decision then given.

The Chairman said they were quite willing.

Mr. Sutcliffe did not see any necessity for that resolution. The terms of the directors were stated in the company's books.

Dr. Small, referring to the last clause in the resolution, suggested that 14 days' notice be given when special business was to be transacted, and

The Chairman said that the directors had no objection to fall in with Dr. Small's suggestion.

The Chairman said they then came to the last resolution, which ran thus:—"The directors may from time to time sell, lease, exchange, or otherwise dispose of and deal with all or any parts or part of the property of the company situated in France upon such terms and in such manner as they may think expedient." If the board got the sanction of the shareholders, they would be able to act promptly; without it, they would have to go through a form that might, perhaps, place them in such a position as to lose a favourable opportunity of disposing of their works.

Mr. Bannatyne seconded the resolution, and it was agreed to without discussion.

Mr. Bevan proposed a vote of thanks to the directors for their services, and

The Chairman, in the name of his co-directors and himself, returned thanks. He said he had already referred to the attention given by the board to the interests of the company. Upon them much of the credit due to Mr. Gray had fallen, and he assured them that their attention to the interests of the shareholders would not slacken in the least, and he hoped to meet them 12 months hence with as satisfactory a report as they had on the present occasion rendered.

Maxim-Weston Electric Company, Limited.

THE fifth annual ordinary general meeting of the shareholders of this company was held on the 19th inst. at the Cannon Street Hotel, Mr. Hugh Watt, M.P., in the chair.

Mr. John Wright (the acting secretary) read the notice convening the meeting, and the report of the directors, published in the REVIEW last week, was taken as read.

The Chairman said: It is now a year since I had the pleasure of addressing you in general meeting. Since then we have had occasion to meet on two separate occasions, and I think I need not refer to the object of those meetings, except to say that immediately afterwards we secured the sanction of the court to the resolutions which had been submitted, passed, and confirmed by the shareholders. We secured that without the necessity of adding the word "reduced" to the title of the company, as is sometimes insisted on. On the last occasion, a year ago, when I addressed you, I ventured then to enter somewhat *in extenso* into the past history of the company. On this occasion I do not think it is needful or desirable that I should do so. I trust as long as we hold the position we do we will learn what lessons we can from the past and endeavour to utilise them for the advantage of the company in the future, and I do not think it would be either wholesome or desirable to go into the early and unfortunate history of this company. Well, gentlemen, I think I need not inform you further, as the report, I trust, has reached every shareholder. I have had a few complaints, and I mention this inasmuch as on a previous occasion we also had some complaints, but on this occasion I may mention, perhaps, that I personally supervised the forwarding to every shareholder the balance-sheets and report. It was, if I remember rightly, on Saturday; but we remained late and accomplished the work in one day, so that every shareholder might receive the statement simultaneously. Well, I do not think I need add that the financial position of the company to-day is stronger than it ever has been. I think the cash reserve at bankers and on deposit is sufficient to prove this fact, and I do think further that in view of the strong cash position of the company we are warranted in submitting to you a recommendation as to the payment of a dividend. I ventured, at an extraordinary meeting, after the business for which the meeting was convened, the only business which could legally be transacted at that meeting, had been closed, to submit a short statement as to the position of the company, the contracts which had been carried out or were in progress—a short *résumé* up to that date. This naturally leaves me very little to say to-day. The proposal that a suggestion should be made from the other side of the table with regard to the amount of dividend which we were entitled to, and ought to pay, led to the board making the recommendation which we shall do to-day, namely, to pay a dividend of 7½ per cent. upon the present amount of capital. Well, gentlemen, as I suppose I may assume that most of the hon. proprietors I have the pleasure of addressing to-day are business men, it is unnecessary for me to go into the general question of trade depression; you all, I am afraid, are only too familiar with that subject. It must, therefore, be, I think, to some extent, gratifying to the shareholders of this company that, passing under a crucial period such as the last year, we are able to come here to-day with a substantial profit after the payment of all legitimate and working expenses. In connection with another company, I saw a noble lord the other day ventured to submit what must be gratifying to all investors in electric lighting enterprise, the fact that electric lighting generally is improving. Well, I have pleasure in endorsing his sentiments. It is not only improving, but we have inquiries for it from the darkest, and may I almost add, from the uncivilised quarters of, I can hardly say, Christendom. Such being the case, and constantly receiving inquiries from all parts of the world for installations, we have had orders from nearly every colony, and have found them a more lucrative field than the home markets, containing as they do such a plethora of dynamos and other plant of almost every make and manufacture. We have, therefore, occupied our attention during the past year to a large extent with colonial and foreign trade, and during the last two months have made several of the largest shipments of electrical lighting plant upon order that have ever been made, I suppose, from this country, or almost any country. During the last year, I am happy to say that although our books do not show a largely increased value of plant to the profits, yet we turned out in weight—that is, in numbers of machines, lamps, and so on—a very much larger amount than last year. The reduced sale price of the plant was owing to the amount of competition we have had to submit to. Last year in addressing you for the previous year, I ventured to express the hope that we would be able to secure continued prices and a larger business. Such, however, did not turn out to be quite up to my expectations, and I have no hesitation in saying that the position of the company to-day, and the amount of business we have been able to carry through, have not been up to my expectation. I did not know at that time that other companies who were on the verge of liquidation, and who have since unfortunately gone into liquidation, had such a large amount of plant on hand, the result being that of course the liquidators of those companies in winding up the affairs of those companies had to submit to auction an enormous amount of plant. That naturally depressed very much the enterprise for the past year. At the same time I have pleasure in stating with regard to patents held by this company to date we are still in the forefront, and I do not think any better lamp has yet been discovered, although we have from day to day and from month to month, if I may say so, been kept upon the tenterhooks of expectation of something coming out which will entirely eclipse the Maxim-Weston. So far, nothing of the kind has happened. We have continually gone on experimenting and improving on our patents, and, partly with the view to that, we are on the eve of making arrangements for taking a larger factory, a place where we shall be able to manufacture not only what we are at present manufacturing, our own dynamos, but all the plant of the company, only excepting incandescent lamps. With regard to these, I have concluded such an arrangement with the American Company that I do not find it possible for us to go into the expense of laying down a special plant for incandescent lighting and carrying out that, as compared with the price to which I have been able to squeeze down the American Company. I may also say, as I have referred to the parent company in America, that so far they have met us very fairly. The only difficulty during the last few months has been their inability to supply us with sufficient despatch with the plant we have required. That is entirely owing to the enormous development of their business, and there are £2,000,000 or £3,000,000 profitably employed in the manufactures and installations of sub-companies of the American Company throughout the States of America. That I think is a sufficient guarantee that our plant is all it was promised to be when we took it over subject to such improvements as we have made. During the present year I hope we shall be able to improve considerably our arc plant. Our efforts hitherto have been mainly directed to endeavour, by means of experiment, to secure better results—that is, to enable us, through the same dynamo, to run a larger percentage of lamps, which of course proportionately cheapens the machine. In that way we have been able to a great extent to maintain the price of our various machines by securing, through winding and otherwise, better results in the number of lamps. Well, I hope during this year we shall be able, by undertaking the manufacture of this plant to save something like probably 20 to 30 per cent. upon the cost price of machines to us. This is a very material matter, because during the last two months I have been negotiating with almost every country in Europe, over and above the colonies, with the view of increasing our business. The result of that, as far as we know, is that the price charged us by the American Company virtually puts us out of the market in competing with the competitors on the Continent. I am in hopes, by means of larger premises, and the results which I think we shall obtain in the next three months in connection with the arc lamp, to be able to compete with a good profit with our Continental opponents. Their material is cheaper—their

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iron is cheaper, labour is cheaper, premises and other expenses connected with the manufacture are cheaper, so that if we can manage to compete in places like Germany, that is about all, I think, we can hope to obtain with regard to the cost price of our plant. With regard to the premises, as we venture to mention this in the report, I may say that we have not secured the premises I named there, inasmuch as after a great deal of trouble and enquiry on our part I am in hopes to save about £200 a year in the rental of the premises we shall acquire, with a frontage of 6,000, 8,000, or 10,000 cubic feet. Our systems, I am happy to say, are growing in favour, and it seems like repetition to add that the Maxim-Weston installations have given great satisfaction. The last installation carried out and completed has been that in connection with Her Majesty's Post Office Department for the Government. I am happy to say, after numerous experiments, first of all directed to enable us to secure a steady non-flickering light by means of a gas engine, which we successfully overcame—I think I may say, in all humility, for the first time in the history of electric lighting companies; and the next thing by a sub-division of the light to obtain the greatest results and most varied at the lowest cost, for that really, after all, is the acme of electric lighting, and what we are all hoping to obtain in our competition with the greater power—gas. In connection with the installation in the Savings' Bank Department, there we had to contend with the difficulty of switching on and off from one room to another, and if we managed this in the case of 36 different circuits from the same machine, we would effect an economy varying from 30 up to 60 per cent. Well, gentlemen, we had no data to go upon; we had simply to rack our own brains, and find out, by means of a switch-board, what would answer all purposes to arrange from three machines a switch of 36 circuits. With the manager of our works, who is a man second to none in his profession, after some two months' time we have accomplished a switch-board, which the officials of the Post Office, including one of the best known, Mr. W. H. Preece, told me was entirely successful. We were met by the chief men connected with the Postal Department to investigate this installation. It was the first run, and, of course, the first run is not often the best, but Mr. Tough was so satisfied with regard to the switch-board, that we allowed the officials to be present at the test trial. The result was entirely successful, and after two or three hours' running, the Post Office officials were pleased to express their entire satisfaction, and to pass the installation. I may mention that we have entered into an agreement with the Post Office Department to run it for two years at a very handsome rental, thereby in a great measure guaranteeing the efficiency and the durability of our plant, a point we naturally base a good deal upon with regard to the future.

A Shareholder: Are they incandescent?

The Chairman: The installation is incandescent. There are at present 700 lamps running. I may say they intend duplicating this installation. One difficulty has been with regard to a tenant whom the Post Office authorities had arranged to buy out, and increased basement accommodation. When that is completed, I think I may safely say the Post Office will give us a duplicate contract. It is to be regretted that delay has taken place, but it is the largest installation we have ever undertaken, and I think, after the success which has attended it in enabling us to switch off from 36 different rooms on to any of three machines, that we are prepared to say we can carry out lighting of almost every description and of the most varied character. Well, gentlemen, we have done our best in the matter of increasing the number of agents. We have some valuable agents, who have got us a considerable amount of business during the last few months. Whether it is that our repute is going up from outside sources I do not know, but we have had enquiries from the first electrical agents throughout the country, England, and Scotland, for agencies for this company. Hitherto agents have been very much of this disposition, they have wanted all the profit to themselves. I have no objection to give an agent a fair commission, but I do object to allow him to get the entire profit in view of the fact that the company have expended £140,000 in connection with their patents. My colleagues and myself have endeavoured to put the report and balance sheet in as clear a form as we could. The first paragraph refers to the fact that during the past two years no sum had been laid aside for bad and doubtful debts and other contingencies, and we have now deemed it prudent to pass a sum of £3,606 5s. to the credit of a general reserve account. I mention this, because in taking larger premises we shall have to do a good deal in putting up fixtures, and that fund is available for that as well as other emergencies. During the last two years and nine months I do not think we have contracted £500 to £600 of bad debts. The total balance at the credit of profit and loss account is £5,284. Well on the last occasion, gentlemen, you thought proper to veto my proposal, which I daresay you will give me credit for having made in perfectly good faith, to declare a dividend. I have no wish to dispute the wisdom of the decision, but it enables us to declare a dividend in excess of what it would have been if the balance had not been carried forward. To-day, I think I may say, the company is in a position not only to warrant but to entitle us, to pay the dividend such as we propose of 7½ per cent. With regard to the Electric Lighting Act, that is somewhat a personal matter. I hope as soon as the present Government get fairly settled down to business, and this perpetual question of Ireland gets disposed of, I shall be able to induce the President of the Board of Trade to consider suggestions which I trust to have the pleasure of putting before him. In conclusion, the Chairman expressed his belief in the future of the electric light, although he said he did not take the sanguine views expressed at another meeting as to the numbers of people it would employ. He moved the adoption of the report.

Mr. Louis Swaby, in seconding the motion, said they did not intend to do what many other companies had done, namely, exhibition work at a loss. He thought they should give credit where credit was due, and he was sure the success of the Maxim-Weston Company was due to the chairman. He had had no light work. It had not been ten-to-four routine business; but Mr. Watt had devoted his time early and late, and had worked hard for this company, and he thought the whole of their thanks were due to him.

Mr. Griffiths had been informed that there had been an issue of new capital, and suggested that if new shares were issued they should be offered in the first instance to the shareholders.

The Chairman said there had been no new issue of shares, and the directors had not the power to make an issue without the consent of the shareholders.

The motion was subsequently carried.

The retiring directors and auditors were re-elected, and the directors were voted £500 for their services.

A vote of thanks to the chairman and directors then terminated the proceedings.

Telegraph Construction and Maintenance Company, Limited.

The report of the directors states that the accounts for the year show a net profit of £82,740 15s. 8d. after charging the interest on the debentures. To this sum must be added £72,166 8s. 7d. brought forward from last year, making a total of £154,907 4s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 21st, 1885, amounting to £22,410, leaving £132,497 4s. 3d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £65,267 4s. 3d. to be carried forward to the next account.

The operations carried out during the year 1885 have been as follows:—

(A) In April a contract was entered into with Her Majesty's Government for the manufacture of 1,000 miles of submarine cable, which was completed in May.

(B) In the latter month a cable, 322 miles in length, was laid for her Majesty's Government from Shanghai, in Northern China, to Port Hamilton, off the coast of Korea.

(C) Between April and June a cable, 740 miles in length, was manufactured for the Eastern and South African Telegraph Company, and laid in August, as a duplicate line between Zanzibar and Mozambique.

(D) The Heligoland-Cuxhaven cable has been partially relaid and put in good working order.

(E) Early in the year the Fastnet Rock, 8 miles off the south-west coast of Ireland, was connected by a submarine telegraph cable with Crookhaven, as an experimental signal station for Lloyds, and, with the exception of one interruption, caused by heavy weather, it has continued to work up to the present time.

Telegraphic communication with the "Sunk" light vessel, stationed 9 miles off Walton-on-the-Naze, has been maintained with but slight interruption during the year, and since the experiment has taken its present form, it has been successfully maintained for 306 out of 311 days. Since the 11th of November communication has remained perfect, notwithstanding the unusual prevalence of heavy gales.

(F) In addition to the above-named operations, various lengths of cable, amounting to 763 miles, have been manufactured for several telegraph companies and Colonial Governments.

The company's steamships *Calabria* and *Kangaroo* have been chartered by Her Majesty's Government for condensing purposes in the Soudan for the periods of five and nine months respectively during the year. The steamships *Britannia* and *Seine*, reported as building and refitting in the last annual report, have been taken over by the company; and the whole of the company's ships, as well as the factories at Wharf Road and East Greenwich, are in efficient working order.

The Swan United Electric Light Company, Limited.—An adjourned general meeting of the shareholders was held at the Cannon Street Hotel on Tuesday, when Mr. F. R. Leyland, who presided in the absence of Mr. J. S. Forbes, stated that as the negotiations with reference to the company's business had not been brought to a definite conclusion, it was desirable to further adjourn the meeting to Tuesday, 23rd March, at which date the report and accounts up to 30th September, 1885, would be submitted to the shareholders, and the position of the negotiations and of the business up to 31st December, 1885, be fully explained by the Chairman. The meeting was accordingly adjourned.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 19th were £2,560, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for last week amounted to £3,241.

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NEW PATENTS—1886.

2290. "Electric testing apparatus." J. S. RAWORTH. Dated February 17.

2317. "Electrical switches." C. BROWETT. Dated February 17. (*Complete.*)

2322. "Method of metallising woven textile fabrics, especially flannel, in order to develop electricity for hygienic and medicinal purposes." L. A. GROTH. (Communicated by U. R. Pumariega.) Dated February 17.

2348. "Manufacture of arms or insulator bars for telegraph poles and telegraph insulators." D. WILSON. Dated February 17. (*Complete.*)

2372. "Electro-magnets." T. B. GRANT. Dated February 18.

2378. "Electric bells." S. A. VARLEY. Dated February 18.

2403. "Operating electric smelting furnaces." H. J. HADDAN. (Communicated by E. H. and A. H. Cowles.) Dated February 18. (*Complete.*)

2410. "Leclanché battery." A. LEVY. Dated February 18.

2433. "Dynamo-electric machines." T. A. GARRETT. Dated February 19.

2452. "Regulating or controlling engines driving dynamo-electrical machines." H. H. LAKE. (Communicated by E. H. Armet.) Dated February 19.

2456. "Holders for incandescent electric lamps." J. LEE. Dated February 19. (*Complete.*)

2470. "Electrical locomotion, propulsion, or traction and apparatus therefor." E. JULIEN. Dated February 19.

2479. "Electric cables." W. T. GLOVER. Dated February 20.

2494. "Instantly sending a signal by means of electricity for turning out fire engines, to be used in connection with an ordinary metallic telephone and electric bell circuit." F. E. STUART. Dated February 20.

2513. "Telegraphy." A. J. BOULT. (Communicated by B. B. Toye.) Dated February 20.

2525. "Electric conductors." J. G. PARKER. Dated February 22.

2554. "Lanterns for electric arc lamps." W. A. S. BENSON. Dated February 22.

2608. "Siphon recorders." W. P. THOMPSON. (Communicated by C. Cuttriss.) Dated February 23. (*Complete.*)

2615. "Absolutely continuous current dynamo-electric machines." C. J. HALL, W. LAWRIE. Dated February 23.

2625. "Primary electric batteries." R. HARRISON. Dated February 23.

2630. "Electrical indicators." B. J. B. MILLS. (Communicated by J. W. Howell.) Dated February 23.

2631. "Electric batteries." J. Y. JOHNSON. (Communicated by L. A. W. Desruelles.) Dated February 23.

2632. "Treating and preparing materials used in electric batteries." J. Y. JOHNSON. (Communicated by L. A. W. Desruelles.) Dated February 23.

2647. "Galvanic batteries." L. N. LOEB. (Communicated by J. H. Howard.) Dated February 23.

2648. "Galvanic batteries." L. N. LOEB. (Communicated by J. H. Howard.) Dated February 23.

2652. "Speaking telephone transmitters." W. C. TURNBULL. Dated February 23. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3260. "Improvements in secondary batteries or accumulators." J. PITKIN. Dated March 12. 8d. According to the invention the elements are constructed of a central plate or support of lead or other conductive material, against which the spongy lead or the peroxide of this metal is held by frames of ebonite and external perforated plates of the same material.

3332. "An improved ventilating armature for dynamo-electric machines." A. L. DAVIS. Dated March 14. 8d. Consists of an armature of the ordinary H iron shape, but instead of being either of solid iron or consisting of T shaped pieces, joined at the axis of the armature as is generally done, the armature is formed of discs of sheet iron of suitable thickness, punched out in shape of the end section of the aforesaid H iron armature with holes through each disc, near the periphery of such disc, through which pass two or more longitudinal bars or rods of metal. These bars or rods are covered with a tube or layer of ebonite or of other non-conducting substance, so as to effectually insulate them from the sheet iron discs, which discs are separated and kept at equal distances apart by alternate washers of iron and insulating material threaded on the longitudinal bars aforesaid. These bars are secured at each end to a plate or hub of gun or other non-magnetisable metal by means of suitable nuts and screws so as to ensure the rigidity of the whole structure. To these plates or hubs are again secured the journals or spindle on which the armature revolves.

3987. "An improved portable electric lamp." A. V. ROSE and G. F. ROSE. Dated March 28. 8d. The stand or pillar of the lamp constitutes or contains a receptacle for the electrolyte and elements of a battery, which elements are carried by a cover and consist preferably of carbons and zincs, the carbons being secured to the cover by screws and nuts or other means of attachment, the zincs being secured so as to be readily removeable by means of spring clip pieces with teeth or projections taking into recesses in the end of the zincs. The said elements are preferably in long narrow strips in series side by side and with non-conducting buttons or projections on the carbons to prevent contact between the elements due to distortion thereof. The clips which secure the zincs have thumb pieces projecting above the cover which can be pressed together to open the gripping jaws of the said clips and the bearing pieces of the clips on the elements may be made of platinum. Attached to the cover is a rack with which engages a pinion or toothed shaft carried by the lamp vase or cover by rotating which the elements can be raised or lowered all at the same time from or into the electrolyte.

4110. "Electric arc lamps." H. W. PENDRED. Dated April 1st. 8d. Refers to improvements in the lamp patented by the inventor No. 3210, February 13th, 1884.

8627. "Improvements in galvanic batteries and in the electrodes of electrolytic converting tanks or troughs." W. H. TASKER. Dated July 16. 8d. Relates to the construction of elements for galvanic batteries, particularly the negative elements of lead primary batteries, and it has for its principal object to provide a support for the active material or "depolarising agent" constructed of a substance which shall not be liable to become disintegrated by the effect of electrolysis, with means of making good conductive connection between the active material and the terminal of the element. The invention may also be applied to the electrodes of electrolytic converting tanks or troughs. The support is constructed of a foundation of gutta-percha, India rubber, celluloid, xylonite, or equivalent non-conducting and either inoxidisable or but slightly oxidisable substance, to which strips or wires, &c., of conductive and inoxidisable material (preferably gold or platinum foil) are applied in such manner as to be retained securely in place, and at same time make efficient contact with the active material.

CORRESPONDENCE.

Electric Alarms and Indicators.

We notice in your last issue a letter emanating from the pen of Mr. H. Albert, in which we are accused of using an idea of his to our own purposes. We should prefer passing this by and not giving you trouble or occupying valuable space in your journal by refuting it, were it not that such charges, however unfounded, are misleading to the general public, and apt to be injurious to us if allowed to pass unnoticed.

Now, the idea we are stated to have appropriated is, that when the disc of an electric indicator falls, it should complete a local circuit and cause the bell to ring until the said disc is replaced.

Had your correspondent taken the trouble to make enquiries, he would have found that such methods were known and in use long before the time he claims to have invented it. We, ourselves, could have given him the names of customers supplied by us with indicators containing similar arrangements eight or nine years ago.

From his concluding remarks, Mr. Albert seems to regret that it is not in his power to protect his inventions, but had he the means, it would certainly be a pity to waste them by taking out patents for things known to have been in use for years.

E. Thurkle & Co.

February 17th, 1886.

Telephone Patents.

Your correspondent "Combination," when he speaks of "the monopoly of the firm that will not sell telephones," cannot be aware that for many months past the New Telephone Company, Limited, has been selling telephones, "out and out," at reasonable prices. As he seems to suppose that a diaphragm is a necessity in a

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transmitter, will you allow me to point out to him that in the valve telephones supplied by us, the transmitter has no diaphragm, the valve-piece standing clear in the top of the speaking tube, which is open from end to end. As I do not wish to use your correspondence columns for advertising purposes, I will not trespass further upon your space with descriptions of the instrument.

J. W. Barnard, *Secretary.*

New Telephone Co,. Limited,
4, Great Winchester Street,
London, E.C., *February 22nd*, 1886.

[The instruments used by this company (Prof. S. P. Thompson's) have already been described by us.—EDS. ELEC. REV.]

The Invention of the Telephone.

Dr. Lawson Tait in his letter, of which I have just seen the reprint in your columns (of January 15th), does me the honour to recall my name as that of a "very well-known man in Edinburgh" during his student years at the University, and he "feels almost certain" that he has seen me as "one of the frequenters" of a shop where Reis's telephone was exhibited in December, 1862. Dr. Tait "thinks it extremely likely" that I would go to the shop to see the telephone, and that I "might have been accompanied" by my son; and he further thinks that "nothing is more likely than that it was through this chain that Reis's telephone was transferred to America, and there became developed." Allow me to say that Dr. Lawson Tait's conjecture is entirely baseless. So far from being a "frequenter" of the shop referred to, I was never within its doors; and I never even heard of Reis's telephone until years after 1865, when I left Edinburgh. My son at the date specified by Dr. Tait was 15 years of age, and a pupil at the High School.

Knowing all the stages of my son's laborious efforts before he finally achieved the telephone, I know that his work was not suggested or directed by anything that Reis had done. At the time the telephone first began to speak, the whole world was astounded. The very idea was entirely new. Had Reis's instrument transmitted speech in 1862, how came it that the fact failed to be recognised as the marvel it undoubtedly must have been accounted? There is only one explanation. The sounds conveyed by Reis's instrument sometimes resembled words, or parts of words—as musical notes often do to imaginative listeners—but, as a matter of fact, Reis's telephone, without modification in accordance with the principle discovered by Alexander Graham Bell, has never, to this day, accomplished the transmission of an articulate sentence.

Alexander Melville Bell.

Washington, D.C.,
February 8th, 1886.

Some Points in Electrical Distribution.

We regret that we were unable to attend the meeting of the Society held on the 19th inst., but having seen the report of Professor Forbes' paper on the above subject in the last number of the Society of Arts Journal, we wish to draw attention to two statements made by him, and which we are surprised to see were not commented upon in the discussion which followed. The observations we wish to make relate to that part of his paper touching on secondary generators, and in which mention is several times made of the Grosvenor Gallery installation erected under our supervision for our clients, Sir Coutts Lindsay and Company, Limited. In speaking of *parallel distribution* by generators, Professor Forbes seems to labour under the impression that the same difficulties are met with as is the case in ordinary parallel lighting, viz., the fall of potential along the line, varying in proportion as the current is increased or diminished by generators being turned off or on. This fall of potential is dependent on the ratio that the amount of loss on the line itself bears to the maximum amount of work that is carried by the line. In the case of direct currents this ratio may be 10 to 20 per cent., while in the case of high tension currents it can be reduced as low as 1 to 1·5 per cent.

As the variations in potential must be proportional to the variations of the amount of work lost on the line—in the case of direct currents, where this variation may reach 20 per cent.—a corresponding *pro rata* variation in potential must be met in the manner mentioned by Professor Forbes, but where this variation is only 1 or 1·5 per cent. such precautions are not required, as generators or transformers in parallel are capable of maintaining practically the same potential in their secondary circuits, no matter where their position may be, or how the load along the line may be varied.

Again, speaking of generators in series, the lecturer stated that if "a double wire be used to prevent affecting telephones, it is half the weight"; but we fail to understand how he would propose to thus obviate induction on telephone lines, without at the same time doubling the weight of the entire conductor. We notice he gave no diagram of this proposed arrangement.

Another matter we cannot refrain from referring to is that of the automatic regulation of the secondary current when the generators are run in series.

The *modus operandi* seen by Professor Forbes, though practically originated by us, did not appear as successful in our estimation as it seems to have done in his, and for practical purposes has had to be abandoned.

Mackenzie & Brougham.

February 23rd.

Re Andersen's Formulæ.

In reply to "Ohm's" enquiry of last week, I wish to say that I think the formulæ in Part II. of my paper (November 21st and 28th), numbered II., III., IV., VI., and VII. respectively, the practical use of which is illustrated in the test-table with remarks, contain the guide required. The values of a and V will have to be decided for each case according to circumstances, that of F corresponding to a certain value of $\frac{w\,m}{W}$ must be known from tests made on the particular type of dynamo in question. In the old Gramme dynamo, it was ordinary to have by a value of $\frac{w\,m}{W}$ (proportionate waste in field magnet coils) of from ·12 to ·16, F equal to ·0075 to ·008. In modern dynamos we can find by $\frac{w\,m}{W} = \cdot 04$ a value of F equal to ·013. I am not prepared for the present moment to publish any general formula for ascertaining F in a theoretical way.

F. V. Andersen.

February 23rd, 1886.

Private Telephonic Communication.

Will you please inform me whether I could fix a telephone line in Birmingham for own private use without having to pay any royalty; should I have to get permission from the Corporation or from the National Telephone Company, which is the only company in this town, buying another company's instruments? Sorry for taking up space.

H. Aston.

39 and 40, Smallbrook Street,
Birmingham.

[It would only be necessary for you to obtain permission from the owners of the property over which the line is to pass; no royalties would have to be paid either to the Corporation or to the National Telephone Company. You could not, however, work the line telephonically unless the instruments used were clear of the National Telephone Company's patent rights.—EDS. ELEC. REV.]

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 432.

GOVERNMENT TELEGRAPHS.

THE advantages which accrue from the exclusive Government control of a system like that of the telegraph have been often questioned, and it is but little likely that all parties will be agreed upon the point. There is much to be said on both sides. In the case of the telegraph system in this country the Government holds a monopoly, and monopolies are always bad, say some, because they lack the stimulus to which competition gives rise. If it were a case of a commercial and not a Government system, the argument would have far more force than it has actually. A system carried on by private individuals or by a company has for its prime object the payment of good dividends upon the capital invested in the concern, and the convenience of the public is not considered except in so far as such consideration may tend to promote the object in view, viz., a good return upon the capital sunk. In regard to the telegraph system of this country, the extension of the means of carrying out the work, which took place on the transfer of the various systems to the State, was most marked and has continued to be so up to the present time. Consistent with the expenses not exceeding the receipts, the convenience of the public has been consulted in many ways, and notably in the opening of offices in country districts where the amount of remunerative work is very small. Such extensions were not, and were not likely to be, contemplated when the telegraphs were in the hands of the companies; they would not pay, and that was the end of the matter. But now with regard to another point—it has been more than once stated that the effect of the Government monopoly has been to stifle invention; and quite recently our American contemporary, the *Electrical World*, contrasts what has been done respectively in America and in England in the following words: "The English Government last Thursday completed their 16th year of monopoly of the telegraph lines (February 4th, 1870). They have little improvement to show for their 16 years of exclusiveness, except their record of a determined effort to crush out the telephone. On the other hand, during that period we have tossed off the duplex, the quad, the telephone, and a few other trifles that are only born of or nurtured by a spirit of keen competition." Now it is, perhaps, hardly necessary to restate the well-known fact that neither the duplex nor the quadruplex is exclusively an American invention. The general principles of both are now over 30 years old; the apparatus as at present worked are improvements on the original idea, most marked improvements undoubtedly, but still improvements only. As regards the quadruplex, it was found necessary to entirely remodel the apparatus from the American patterns; had the latter only been available we believe that there would not now be a single set in use in this country. The statement that the Postal Department "have little improvement to show for their 16 years of exclusiveness" is very far from being correct, but is due to the ignorance of the writer, a not unnatural ignorance, perhaps, seeing that the many improvements effected are not regularly made known through the scientific journals. It may not be amiss to mention the fact that the Wheatstone automatic instrument which at the time of the transfer of the telegraphs to the State was only capable of working at a speed of 50 to 60 words a minute, has been so far improved by the Postal engineers as to enable a speed of 450 words per minute to be attained. Of the numerous small but important improvements which have been "tossed off" it is unnecessary to speak, but we emphatically repeat that they exist though they are not generally known to the public. Whether under the old competition system greater strides would have been made is, of course, a question which it is impossible to answer, but that under Government control invention has practically ceased is not proved, in fact, it is an incorrect statement, despite the lamentations of many disappointed inventors.

THE WORK PERFORMED IN TELEGRAPHING.

By W. MOON.

WHEN work of any kind is performed energy is expended, and this expenditure takes place in two or more forms. In telegraphing a message energy is expended in at least four different forms. Thus, in sending a message on a sounder circuit, human labour is required to work the key, the battery performs work throughout the circuit, work is performed in the movement of the receiving apparatus, and finally energy is expended in producing the sound. Again, if the message is signalled automatically, mechanism is used at both ends of the circuit, and finally the message might be perforated with pneumatic apparatus. The energy expended in these various forms may be expressed in one common measure, and the amounts of energy expended in each form, and in each operation, may be calculated with tolerable accuracy.

In all the following results I give the energy in foot pounds expended in telegraphing the average word. An average word contains 5·75 dashes and 8 dots; or is equal to about 14 signals on a key and 20 depressions on a perforator.

Firstly, as to human labour. The net work performed by the clerk may be determined by multiplying the number of signals by the play of the key by the tension of the spring at the point of application. Thus, the play of a single current key is about $\frac{1}{64}$ of an inch and the tension of the spring 6 ozs. Therefore the net work performed in sending the average word is

$$\frac{14 \times 6}{64 \times 12 \times 16} = \frac{1}{155} \text{ foot lb.}$$

In a similar manner the net work performed with a double current key having $\frac{1}{12}$ inch play is

$$\frac{14 \times 6}{12 \times 12 \times 16} = \frac{1}{27} \text{ foot lb.}$$

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The tension of the springs of single-needle instruments is somewhat greater; say 8 ozs., and the play about $\frac{1}{12}$ inch. Then the work performed is

$$\frac{14}{12 \times 12 \times 2} = \frac{1}{20} \text{ foot lb.}$$

The play of the pedals of a perforator is about $\frac{1}{3}$ inch, and the mean tension of the spring about $1\frac{1}{4}$ lbs.; therefore the work performed in perforating a word would be about

$$\frac{20 \times 5}{3 \times 12 \times 4} = \frac{2}{3} \text{ foot lb.}$$

All of these net expenditures of energy would only represent a small portion of the labour of manipulating; since the greater portion of the labour of manipulating would consist in the movement of the arm itself, and in the fatigue of keeping the muscles contracted when no external work is performed.

It will be observed that the net labour of perforating a word is about 100 times greater than the labour of signalling a word on a single current key; but the gross labour, though much greater, would not, of course, be 100 times as great. The fatigue experienced in manipulating a double-current key is but very little more than that experienced with a single-current key.

Next, as to the work performed by the battery. The energy expended by the battery may be calculated from the formula

$$\frac{\text{E}\, c\, t}{1{,}325} \text{ foot lbs.,}$$

where E is the electromotive force in volts and c the current in milliampères, and t the time in seconds.

The work performed by the battery would vary with the length of the circuit. As an example, suppose a word sent at the rate of 20 words a minute with an E.M.F. of 50 volts and a current of 20 milliampères, then the energy expended by the battery would be

$$\frac{50 \times 20 \times 3}{1{,}325} = 2\tfrac{1}{4} \text{ foot lbs.}$$

This energy would be expended throughout the circuit, principally in the form of heat. The amount of heat generated in the coils of the receiving relay may be calculated from the formula

$$\frac{c^2\, \text{R}\, t}{1{,}325{,}000} \text{ foot lbs.,}$$

where c is in milliampères and R in ohms. For example, suppose one half of the current sent in the last instance reached the receiving station, then the energy expended in heat in the relay coils would be

$$\frac{10^2 \times 400 \times 3}{1{,}325{,}000} = \frac{1}{11} \text{ foot lb.}$$

The amount of energy expended in heat in the coils of the sounder may be calculated with the aid of the last formula. It equals about $\frac{1}{2}$ foot lb. per word.

The energies expended by the movement of the armature of the sounder and the tongue of the relay may be calculated in the same manner as the energy expended in manipulating the key, by multiplying the force with which the armature or tongue is actuated, by the distances through which they are moved.

The force which the coils of a standard relay exert upon the tongue is equal to $\frac{c}{128}$ oz. where c is in milliampères; and the play of the tongue at the contacts is about $\frac{1}{200}$ inch. Therefore the energy expended by the motion of the tongue of the relay in signalling a word with 10 milliampères would be

$$\frac{10 \times 14 \times 2}{16 \times 128 \times 200 \times 12} = \frac{1}{18000} \text{ foot lb.}$$

About one-tenth of this energy would be expended in overcoming the friction at the pivots; the remainder of the energy being expended in the blows of the tongue against the screws at the contact points. Although the amount of energy expended at each blow of the tongue against the contact screw, is only $\frac{1}{500000}$ foot lb., yet this minute amount of energy is expended in four different forms, namely: the friction of the tongue at the pivots, the heat generated by the impact of the contact points, the molecular vibrations set up in the instrument by the impact, and the sound produced. And yet the sound produced is sufficiently great to be heard at several yards distance, in a quiet room.

The force which the coils of a sounder exert upon its armature varies with the distance. In a well adjusted sounder the pull upon the armature is about 2 lbs. when the armature is "up," and about 6 lbs. when the armature is "down"; therefore the mean pull may be taken as $3\frac{1}{2}$ lbs. If the play at the armature is taken as $\frac{1}{128}$ inch, then the energy expended by the armature in signalling a word will be

$$\frac{7 \times 14}{2 \times 128 \times 12} = \frac{1}{30} \text{ foot lb.}$$

About five-sixths of this amount of energy is expended when the armature is attracted; the remaining energy being stored up in the increased tension of the spring, and afterwards expended when the spring pulls away the armature from the electro-magnet. It is probable that only a small portion of this $\frac{1}{30}$ foot lb. is transformed into audible sound, the remaining portion being mostly expended in producing molecular vibrations in the sound box and desk. These vibrations may be readily felt by resting the fingers gently on the desk.

The energy expended by the motion of the sounder's armature, is derived, of course, from the local battery. Thus, when the armature of the sounder is moving towards the coils, it sets up in the circuit an opposing E.M.F., which reduces the current flowing in the circuit; so that the energy expended in the circuit as heat and that absorbed by the opposing E.M.F., *i.e.*, the movement of the armature, are, together, equal to the consumption of energy in the local battery.

It will be observed that the energy expended by the motion of the armature is about one-fifteenth of the consumption in the battery; so that the motion of the armature must produce an appreciable effect upon the current flowing in the circuit. But in the case of the relay the motion of the tongue would produce no perceptible effect upon the current, since the energy expended by the motion of the tongue would be about $\frac{1}{30000}$ of the consumption of energy in the battery.

When a message is signalled automatically energy is expended by the transmitter in driving the slip forward and sending the signals. The mechanism of the transmitter is driven by a $\frac{1}{2}$ cwt., which falls through a distance of 2 feet. The transmitter will run 80 feet of slip, that is, about 400 words, each time it is wound up; therefore the energy expended in running one word is

$$\frac{112}{400} = \frac{1}{4} \text{ foot lb.}$$

In a similar manner the energy expended by the receiver's mechanism for each word received, is found to be about $\frac{1}{6}$ foot lb.

Of all the different forms in which energy is expended in connection with telegraphy, pneumatics is by far the most wasteful. Thus, to produce a cubic inch of compressed air, at a pressure of 12 lbs. to the square inch, requires 1·6 foot lbs., and to "punch" a word about 20 cubic inches of compressed air is required, that is, about 32 foot lbs.

A Wheatstone's A B C instrument requires about $\frac{1}{2}$ foot lb. for each turn of the handle, or about $\frac{1}{60}$ foot lb. per signal sent; so that, roughly speaking, a gross performance of about 4 foot lbs. per word is required.

Batteries for Scarf Pins.—A New York correspondent informs us that mercury and potash batteries are among the best for use with electrical scarf pins. These batteries are enclosed in hard rubber cases which can be easily carried in the pocket.

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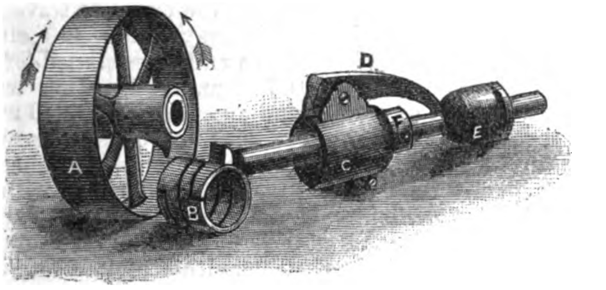
BARNES'S FRICTION-CLUTCH PULLEY AND CUT-OFF COUPLING.

THE Barnes friction pulley and cut-off coupling, which is represented in the accompanying engraving, is described in the New York papers as one of the simplest and most effective friction pulleys known.

In the cut A represents the pulley; B, the spiral spring or sleeve; C, the cylinder carrying the operating lever, and affixed firmly to the shaft at F; E, a movable thimble with a circular slot, in which the fork for shipping is fitted; and beneath C is a screw for regulating the amount of friction.

The operation is as follows: The spiral spring is bored to fit nicely on the turned hub of the pulley, A, the whole being enclosed by the cylinder, C, through a slot in which the projection, cast on the sleeve, passes; the tapered end of lever, D, engages with this, and by sliding the thimble forward or backward, in case two pulleys are used, the spiral spring (which is prevented from turning by the adjustable screw) is tightened on the hub of the driving pulley with any required amount of force, and as the friction increases as the square of the number of coils used in the spiral spring, the driving power is limited only by the strength of materials.

When used as a cut-off coupling, a hub alone is used in place of the pulley.



Amongst its advantages it may be remarked that it does away entirely with a fast and loose pulley and shifting belt, saving one pulley and reducing the width of face required in the driving pulley; saves the wear on the belt occasioned by shifting, and renders the use of a narrower belt possible through the increased tension, which the fact of its not being shifted admits. It gives the workman absolute control over his machinery, enabling him to start or stop it instantly, thus adding to its efficiency and lessening the chance of damage to valuable machinery in case of an accident.

It has no wood or leather in its construction, being made wholly of metal, has no wearing surfaces to be replaced, is noiseless in its operation; where a reverse motion is required, it does its work speedily and effectively.

For electric light plants in factories and mills it is very valuable. It enables the motive power for the dynamos to be taken directly from the main shaft, without resorting to the dangerous experiment of shifting a belt or shutting down while the connection is being made, and will, in many cases, obviate the necessity of employing a special engine for running the dynamos.

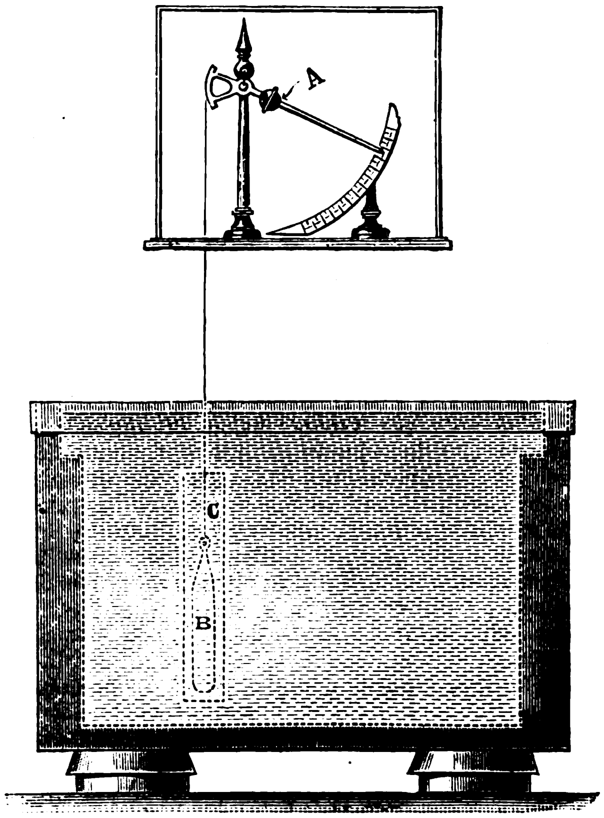
A CHARGE AND DISCHARGE INDICATOR FOR SECONDARY BATTERIES.

WE give below a description of the "Elwell-Parker" secondary battery gauge, or charge indicator, for automatically closing the charging circuit when the cells are exhausted, and breaking it when they are fully charged; also for continuously showing the condition of the charge, and signalling it by a bell or otherwise.

Prof. Forbes at the Society of Arts drew attention to the necessity for a reliable indicator, actuated by the change in density of the liquid for automatically working a switch, and he was not aware that any such was in use; but then Prof. Forbes is noted for overlooking, or not being acquainted with, the labours of previous workers in electrical science.

This instrument, designed upon the principle of the hydrostatic balance, and patented by Mr. Thos. Parker, has been used in connection with the Elwell-Parker accumulators during the past two years and, we are told, with perfect success. It is unaffected by the level of the solution, and does not require a special cell.

It consists of a vertical brass pillar, from which projects a horizontal arm, carrying by two silk cords the beam, at one end of which is the segment of a wheel, the axis of the beam forming the centre, and at the other end is an ivory pointer and an adjustable balance weight.



A glass bulb, B, hermetically sealed and loaded so as to *just* sink in the solution when at its greatest density, is suspended in the centre of the cell by a platinum wire attached within the gauge case to a silk cord hanging from the segment on the beam. The gauge, entirely enclosed in a glass case, is placed upon a shelf directly above the cell, so that the glass bulb hangs in the solution without touching the plates.

It will be at once seen that, as the battery is being charged and the specific gravity of the solution increases, the bulb, B, will rise, and the angle formed by the arm bearing the balance weight, A, with the vertical pillar will become more acute until the pointer reaches the bottom of the scale, when a cross bar formed by a fine piece of platinum wire at the end of the pointer comes into contact with two upright platinum terminals and so closes the circuit, either of an electro-magnetic switch (for automatically cutting the battery out of the general charging circuit), or of an electric bell in the engine house (to show that the charging is complete), or where a gas engine is used to cut off the gas and so stop the engine.

A similar contact may be made when the cells are exhausted (to any desired extent) and the charging circuit thrown in again, or a bell sounded, by the pointer reaching the top of the scale.

As the capacity of a secondary battery, when always discharged in series, depends upon that of the weakest cell it contains, and as every cell will require exactly

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the same amount of current to recharge it, a single indicator placed over any cell is all that is required.

We should be glad to know whether this apparently reliable instrument has been used in any electric light installation outside the laboratory or works, also whereabouts in the cell the apparatus is placed. We were under the impression that the plates in secondary batteries were too close together to get such an hydrometer as that we have described in between; in addition, are not the Elwell-Parker plates separated by grids of ebonite or other insulating material? It may be said, in reply, that it is placed at the end or corner of a cell, but does not the specific gravity of the liquid change more rapidly between the plates than where no action is going on, and does not the specific gravity at the bottom of the cell differ from that at the top? If, on the other hand, one cell of a series is made somewhat more roomy to allow the hydrometer freedom of movement without touching the plates, would it not be necessary in practice to make all the cells of similar dimensions in order that the instrument might be shifted to that cell which may at the time be weakest?

THE ELECTRIC LIGHTING OF LIGHTHOUSES.

THE great utility of the illumination of the coasts, both on account of the security of navigators and for the development of the maritime power of the country has, writes M. Felix Lucas in *Comptes Rendus*, for a long time attracted the attention of engineers and physicists, and has justly excited their emulation in search of improvements. More than any other nation France has contributed to the successive improvement of the appliances for lighting up lighthouses. For the last twenty-five years the discoveries made in the department of electricity have opened up a new field of research.

The lighthouses on the coast of France at present illuminated by the arc light are those of Dunkerque, Calais, Gris-Nez, La Canche, La Hêve, the Baleines and Palmyre. A great number of other lighthouses of the first rank at present lighted with petroleum are about to be converted into electric lighthouses.

In a memoir on "Magneto-electric machines and the voltaic arc in lighthouses," inserted in July, 1885, in the *Annales des ponts et Chaussées*, I indicated the laws and the working conditions of these appliances. We employ in all a force of 4 horse-power to produce 450 Carcel burners, thus obtaining 112 Carcels per horse-power. As the electric current is 55 ampéres and the resistance of the arc 0·43 ohm, the difference of potential between the two carbon points is 23·65 volts and the electric energy amounts to 1,300 watts. Hence, for the 4 horse-power employed the arc absorbs only 1·76 horse-power, the rest is expended on the transmission of power by belting, the rotation of the magneto-electric machine, the internal energy of this machine, and the external current corresponding to the transmission from the machine to the arc.

In fine, the voltaic arc presents, compared with petroleum lamps, two advantages of the first order for use in lighthouses, that is to say, the luminous power and the diminution of the cost of the unit of light. But it is, unfortunately, open to some criticisms, the chief of which relates to the capricious instability of its light. If we observe attentively one of these powerful foci we perceive at once that the great light does not come from the blueish flame which, properly speaking, constitutes the voltaic arc. It comes from the points of carbon raised to incandescence by the enormous elevation of their temperature. The flame of the arc is rather a screen than a focus. It absorbs more light than it gives out. The unsteadiness of the light noticed is due not so much to the variation in the mean difference of the points as to the continual displacement of this screen around the carbon, and the capricious and continual rotation of the incandescent zones around the points. This defect is so inherent in the very nature of the voltaic arc that its complete removal seems unattainable.

But as soon as it is incandescence, and not the combustion or the transfer of the particles of carbon from one pole to the other, which constitutes the main cause of the light, cannot we expect incandescence in a vacuum to furnish a focus as powerful as the voltaic light? It seems to me that in this direction must be sought the future solution of the problem of the electric lighting of lighthouses, and I have for some months studied in this direction.

The conditions which I have imposed upon myself, by reason of the very nature of the object sought, are the following:

1. The luminous focus must present the form of a surface of rotation having a vertical axis, for the light must be equally distributed in all azimuths.

2. We must have recourse to currents of quantity, and to an incandescent body of low resistance, obtaining many watts with few volts, so as to give power to the luminous focus without producing at the same time a lightning-like, or even dangerous tension.

3. The incandescent body can only be of carbon, because it is the only substance which can support excessive temperatures without fusion or volatilisation.

In a memoir inserted in the *Comptes Rendus* of June 8th, 1885, I made known the law which links the luminous intensities to those of the currents traversing an incandescent carbon. We may obtain 400 carcels with a current of 170 ampères and a resistance (of the incandescent body) of 0·04 ohm, or, in other terms, with a tension of 7 volts and an energy of 1,200 watts. In these conditions the luminous unit does not require, for the incandescent part of the circuit, a mechanical work greater than what it requires at present with the use of the voltaic arc. I have estimated the temperature of the luminous carbon at about 4,000° C., and I have found that the carbon is neither melted nor volatilised.

We know that in incandescence lamps there is produced in course of time a carbonaceous deposit upon the inner surface of the glass globe. This gradual decrease of transparence would be especially injurious for powerful incandescence foci. I have endeavoured to determine the true cause, and my experiments prove that it consists in the presence of molecules of oxygen within the lamp. We find, in fact, that the rate of increase of the deposit is in direct relation with the pressure of the internal gas. We should arrive at an infinite slowness, or, in other words, at the cessation of the deposit if we could obtain and preserve an absolute vacuum within the glass globe. A molecule of oxygen not removed combines with the carbon near its junction with the metallic conductor a region in which the temperature cannot reach the melting point of the conductor. There is thus formed a molecule of carbonic oxide. This molecule, then, coming in contact with the incandescent portion, the temperature of which is high enough to produce dissociation, projects the carbon against the inner surface of the glass globe and leaves the oxygen at liberty to combine again.

The realisation of an absolute vacuum in an incandescence lamp is rendered particularly difficult by the tenacity with which carbons and metals retain the gases which they have stored up in their pores. Under the influence of the rise of temperature caused by the passage of the electric current these gases escape at first to a great extent, but the liberation soon becomes so slow that we seem in presence of a phenomenon obeying an asymptotic loss. This loss, which I have clearly established, shows that every apparatus intended to produce the incandescence light on a large scale must be furnished with an absorber capable of constantly storing up, at every point of time in the working of the lamp, the gases which escape in slight quantities from the heated carbons and metals.

It must be remarked, on the other hand, that the gases liberated during the passage of the current and

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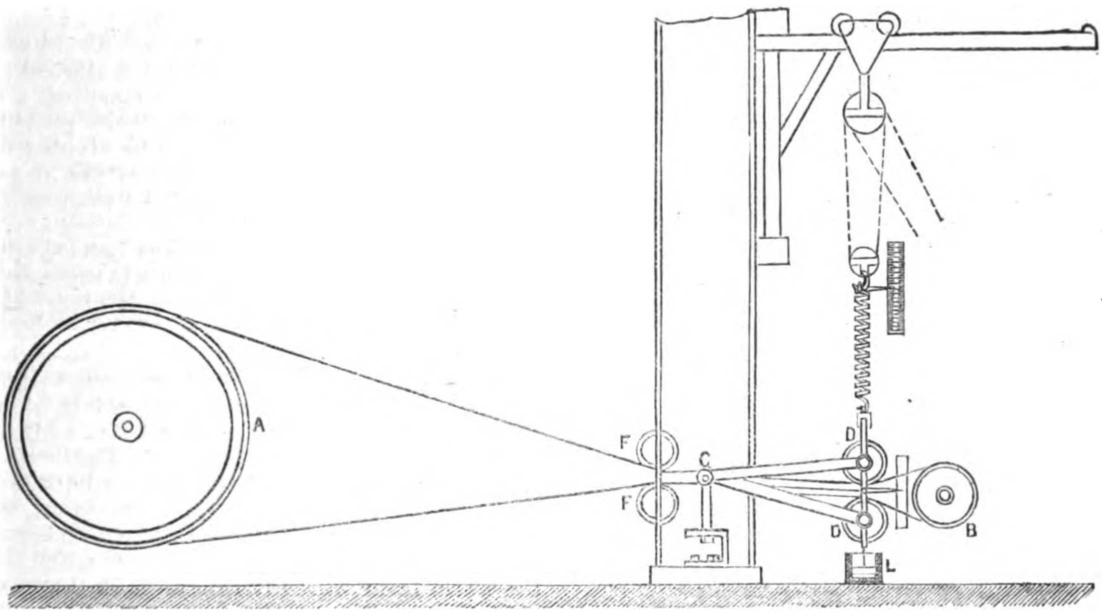
not removed from the apparatus are reabsorbed by the carbons when they become cold. In consequence the presence of a small quantity of gas in an incandescence lamp compels the carbons to periodic disengagements and re-absorptions. Hence a mechanical work is imposed on its molecules, which is one of the principal causes of the destruction, sooner or later, of the lamp. To give a powerful incandescence lamp the conditions requisite for lasting it must be freed from the dangerous influence of even the most rarified gases. I have found that this difficulty may be overcome by the use of absorbent appliances.

DYNAMO TESTING.

ON Saturday last, at the invitation of Messrs. Mather and Platt, a party of gentlemen met at the Salford Ironworks to witness a new method of determining the efficiency of conversion from mechanical to electrical energy by dynamo machines. After making a tour of the various departments of the extensive works, including the large machine shop and foundry, in which men were busy at work upon various operations of a most interesting character, the party were led up to the locality of the electrical operations, now a very important branch of Messrs. Mather and Platt's vast business. Here dynamos were seen of various sizes, and in every stage of manufacture; the centre of interest, however, was the pair of Edison-Hopkinson dynamos, which were coupled up for the purpose of illustrating the new method of measurement. The following statement was supplied to those present as a description of the operations :—" The method hitherto adopted for determining the efficiency of conversion from mechanical to electrical energy by dynamo machines has consisted in a direct measurement of the power transmitted to the dynamo through the driving belt by a transmission dynamometer, and the determination of the electrical power developed outside the machine. The latter portion of the experiment presents no difficulties, and even when large powers are dealt with a high degree of accuracy is easily attainable ; but all who have used a transmission dynamometer know that it is exceedingly difficult to obtain accurate results, even when the utmost precautions are taken, and the difficulty is vastly increased when large powers have to be dealt with. If the power transmitted amounts to 50 horse-power, or upwards, probably few experimenters would undertake to guarantee the accuracy of the observation within limits of even 2 or 3 per cent. ; and the determination of the efficiency will be erroneous precisely in proportion to the error in the dynamometer. Probably, therefore, no efficiency experiments hitherto made on a large scale can be regarded as having any certainty of accuracy within at least 3 per cent.

" During the discussion of the paper on 'Dynamo-Electric Machines,' recently read by Mr. Kapp, before the Institution of Civil Engineers, Dr. John Hopkinson suggested an entirely new method by which the efficiency of conversion can be determined with great ease, and which is not open to the above objection. The method also throws light upon other points of great interest, and especially on the much-discussed question as to the relation between the dynamo when used as a generator and motor respectively.

" Let two dynamos, approximately equal in dimensions and power, have their shafts coupled by a suitable coupling, which may serve also as a driving pulley ; and let the electrical connections between the dynamos be made so that the one drives the other as a motor. If the combination be driven by a belt passing over the coupling pulley, the power required to be transmitted by the belt is the waste in the two dynamos and the connections between them. Moreover, by suitably varying the magnetic field of one of the dynamos, the power passing internally between the



two machines can be adjusted as desired. If, then, the electrical power given out by the generator is measured, and also the power transmitted by the belt, the efficiency of the combination can be at once determined. The beauty and advantage of the arrangement lies in the fact that the measurement, which presents experimental difficulties, is of a small quantity, viz., the power transmitted by the belt. Consequently, even a considerable error in the determination has but a small effect on the ultimate result. On the other hand, the measurement of the large quantity involved, viz., the electrical power passing between the two machines, can without difficulty be made with great accuracy. Assume, for example, that the generator dynamo gives 50 horse-power, and the motor provides 40 horse-power of this amount ; then the driving belt has to supply 10 horse-power only, and an error of 3 per cent. in the measurement of this quantity would cause an error of only 0·6 per cent. in the final result. The method thus obviates entirely the objections to other methods formerly employed, and has at the same time the advantage that the actual mechanical power transmitted to the machines is small, and therefore more readily dealt with by the dynamometer. In fact, an error of ½ per cent. may be considered as the extreme limit, if ordinary precautions are taken.

" The two machines experimented on were of the well-known Edison-Hopkinson type, with all the latest

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improvements introduced by Dr. John Hopkinson and Messrs. Mather and Platt. They are similar in all their dimensions and winding, and are each intended for a normal output of 110 volts, 320 ampères, at a speed of 780 revolutions per minute. They are both shunt wound only, and have solid wrought iron magnet cores and field pieces. The commutators are of copper, insulated with mica, with 40 bars. The general arrangement of the dynamometer is shown in the diagram.

"A is the driving pulley of the engine, B the driven coupling of the dynamos; D, D, are the guide pulleys of the dynamometer turning about the fulcrum, C, and supported by a spring, the tension of which is read by a pointer against a fixed scale, when the index of the dynamometer is brought to its fiducial mark. The potential between the terminals of the generator is measured by a Thomson's graded galvanometer, previously carefully standardised by a Clark's cell, and the current is measured by passing it through a known resistance; the difference of potential between the ends of the resistance is determined by Poggendorff's method by direct comparison with the Clark's standard cell.

"The resistance of the armatures and magnets of the two machines are as follows:—

Generator ...	Armature	0·009947 ohms.
	Magnets	16·93 „
Motor ...	Armature	0·009947 „
	Magnets	16·44 „

"The results of one of a large series of experiments giving entirely concordant results are as given below:—

E.M.F. at terminals of generator	= 110·12 volts.
Current	= 358 ampères.
Current through generator magnets	= 6·50 „
Current through motor magnets	= 5·36 „
E.M.F. at terminals of motor	= 107·33 volts.
Speed of machines ...	= 764 revs. per minute.
Power transmitted by belt ...	= 6604 watts = 8·85 H.P.

"Hence—

Total power given to generator	= 42917 watts	= 57·53 H.P.
Power lost in internal friction of armature core	= 831 „	= 1·11 „
Power lost in generator magnets	= 716 „	= 0·96 „
Power lost in generator armature	= 1360 „	= 1·823 „

"And therefore—

Commercial efficiency	= 93·23 per cent.
Loss in core	= 1·94 „
„ „ magnets	= 1·66 „
„ „ armature	= 3·17 „

"Similarly for the motor—

Total power given to motor ...	= 38886 watts	= 52·13 H.P.
Power lost in internal friction of core	= 831 „	= 1·11 „
Power lost in motor magnets...	= 472 „	= 0·63 „
„ „ „ armature	= 1275 „	= 1·70 „

"And therefore—

Commercial efficiency of motor	= 93·37 per cent.
Loss in core	= 2·14 „
„ „ magnets	= 1·22 „
„ „ armature	= 3·27 „

"In the above experiments, it is worthy of note that Lord Rayleigh's determination of the ohm and of the volt have been taken, and not the B. A. units, as in most previous experiments. The effect of this is to lower the efficiency between 1 and 2 per cent. in comparison with tests made on other dynamos, and at the same time to increase the accuracy of the results by this amount.

"These figures, showing an efficiency for the generator of 93·23 per cent., and for the motor 93·37 per cent., are very remarkable, and show much superior results to those obtained with any other dynamo. They show that the dynamo, whether used as a motor or as a generator, when constructed with due regard to scientific principles, is one of the most perfect of known converters of energy from one form into another. They also entirely put an end to the long-maintained opinion that a motor should be designed on different lines from a generator, or that a dynamo is less efficient when used as the former than it is when used as the latter. It appears that the efficiency of the double conversion is 87·05 per cent. Hence, neglecting the loss due to the connecting leads, power can be transmitted electrically with a loss of only 12·95 per cent.—a result far surpassing any previously obtained."

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XI.

SECONDARY batteries, popularly but unscientifically called accumulators or storage batteries, have been greatly improved within the last two years, and they are gradually gaining in public favour. The literature on the subject of secondary batteries is extremely meagre and what we have is either antiquated or purely theoretical. It is not within the province of these essays to go much beyond the bare statements of what has been d ne with secondary batteries, as regards their weight capacity and efficiency; a complete treatment of the method of manufacture would of itself fill a respectable volume, apart from historical considerations. Some day, perhaps, the story of the storage battery may be written; it would provide ample material to a journalist, it could be divided into many chapters each containing a fair mixture of pathos and of humour; and it would not be necessary to draw upon the faculty of imagination.

To a casual observer, the storage battery appears as a very simple affair, and it is simple to those experienced in its manufacture; nevertheless, it absorbed years of study and vast sums of money.

Ingenuity and skill would have been of little avail had it not been for the liberal support, the wonderful faith, the almost heroic action of a few high minded British Capitalists. France may be the birth-place of the secondary battery, but it was in England where the lead accumulator reached maturity and attained a commercial value and an industrial importance, which can hardly be overestimated when rightly understood.

There are at this moment only two manufactories in the world from which it can be said that serviceable and efficient storage batteries are obtainable, although others are in a fair way of following the lead of these. We refer to the Electrical Power Storage Company and to Elwell-Parker, Limited, but it is the former company, only, which has produced secondary batteries suitable for the purposes of electric locomotion. The E.P.S. cells, among other applications, are used on tramcars and on electric launches with success, and we will now proceed to analyse one of the type especially designed for tramcar propulsion.

Such a cell consists of a strong lead-lined teak box, containing 23 lead plates. The box is rectangular, and occupies a space of nearly one-third of a cubic foot, measured externally. The plates, as is well known, are made of lead grids, the perforations of which are filled with lead oxides. The peroxide plates, generally called positives, 11 in number, are slightly heavier than the negatives containing spongy lead, and of which there are 12 in a tramcar cell. The peroxide and the spongy lead are produced by the process of "forming," that is, sending currents through the new plates when immersed in diluted sulphuric acid. A number of India rubber plugs pressed into a corresponding number of holes in the negative plates, keep the electrodes an equal distance apart. The plates are provided with lugs, which lugs are connected by means of lead strips. The negatives are joined together at one end of the cell, and the positives at the other end. These connecting strips are of sufficient sectional area to carry a current of 150 ampères with safety when

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necessary. The box is provided with a lid which can be hermetically sealed, a hole with stopper serves for the replenishing of acid, which must reach over the top edge of the plates; the said stopper is withdrawn during the process of charging the cell, for the escape of gases, if any.

The weight of a cell is about 40·5 lbs., made up as follows:—

11 positive plates	12·890 lbs.
12 negative plates	11·062 „
Connecting strips	2·423 „
Diluted sulphuric acid... ...	5·125 „
Box and lid	9·000 „
	40·500 lbs.

Expressing the relative weights in percentages, we get for

Lead plates and connectors	65·123 per cent.
Acid, diluted	12·655 „
Receptacle...	22·222 „
	100·000

Of the 26·375 lbs. of plates and connectors, there are 16·375 lbs. of pure lead or "conducting material," and only 10 lbs. of peroxide and spongy lead, which may be termed "active material."

The active material, therefore, forms less than one-fourth (24·7 per cent.) of the total weight of this secondary battery, whilst the conducting grids and terminals, which, though essential, do not, whilst new, materially add to the storage capacity, weigh 40·4 per cent. of the complete cell. In order to decrease the weight of this battery we should have to reduce the amount of metallic lead in the plates, but then we would also reduce the life as well as the strength of the grids, for the lead conductor of the positive electrodes gets also peroxidised in time. This oxidation takes place in an exact ratio to the amount of work that has been done by the cell, the number of watt-hours it has received and returned.

If we reduce the weight of the tramcar cell we naturally save power in propelling the same along with the vehicle, but as the durability is thereby sacrificed it becomes a question as to whether it be cheaper to replace the positive plates frequently or else to provide an excess of energy for this auto-propulsion.

The problem becomes one somewhat similar to that worked out by Sir William Thomson on the subject of conductors for the electric transmission of energy, viz., that the most economical size of a conductor is that in which the interest on the prime cost equals the money value of the energy wasted in heating the same.

With secondary batteries, if we substitute depreciation for interest, the problem of maximum economy is rather more complex, because, whilst we render the plates more durable by providing more material, we also require from them a higher rate of activity since the greater weight demands more power for its own propulsion. But this increase of weight may only represent a very small fraction of the total load of car, passengers and propelling apparatus.

The main points in the consideration of the subject of the propulsion of cars will resolve themselves into three heads: Firstly, the energy expended in the act of carrying the battery with the car; secondly, the energy lost in the process of charging and discharging or the efficiency of the secondary battery; and thirdly, the cost of renewing the plates periodically.

At the ordinary coefficient of resistance to traction on tram rails, one pound weight moved at the rate of six miles an hour will involve the expenditure of seven foot pounds of work per minute. Each cell of the type weighing 40·5 lbs. will thus require 283·5 foot pounds per minute for its own transport. If we were to place 60 such cells upon the 5-ton car, which has previously served as an example, the weight will have to be increased from 11,200 lbs. to 13,630 lbs., and the propelling power (exclusive of motor friction) will have to be augmented by 17,010 foot pounds per minute, which in round numbers means an increase of nearly 22 per cent.

We now place this car upon the line, fig. 8 (article VIII.), and run it at the same speed as before when the energy was supplied through conductors.

The average horse-power, which we then found to be 3·99, will now be 4·88 horse-power at the terminals of the motor, or the battery, as there is no appreciable resistance in the conductor between the two. Twelve such cars with accumulators will, therefore, require 58·56 electrical H.P. for their continuous propulsion. The cars *without* accumulators, exclusive of heat waste in conductors, absorbed 48·54 electrical H.P., but including the heating of conductors 64·84 H.P.

The useful capacity of a tramcar cell averages 140 ampère hours at a high rate of discharge when the average E.M.F. is 1·9 volts; we have thus a store of energy = 140 × 1·9 watt-hours in a cell, and this represents $\frac{266}{736}$ = ·36141 H.P. hour; this gives 21·6846 H.P. per minute, or in terms of the unit of work 715,592 foot pounds.

Comparing the energy per minute with the weights we obtain some very useful numbers—

$\frac{715592}{26·375}$ = 27,523 foot pounds per pound weight of plates and connectors.

$\frac{715592}{40·5}$ = 17,668 foot pounds per pound weight of the whole cell.

$\frac{715592}{10}$ = 71,559 foot pounds per pound weight of active material.

We may also deduce the relations between weight and coulombs, or weights and watts, but these are not so handy for calculations as the foot pound minutes, or horse-power minutes. The capacity of an accumulator increases slowly as the conducting substance becomes peroxidised, or as the plates get older in use.

ON TELEMICROPHONIC APPARATUS.

By M. E. MERCADIER.

I GIVE the name telemicrophonic to mixed apparatus which produce simultaneously the effects of microphones and telephones and which are reversible like the latter. Their construction, as regards transmission, rests on the following facts:

1. We may act upon a telephone or a microphone by the intervention of any thin *rigid* plate whatever and of a stratum of air, limited or not.

2. We may, without causing a magnetic diaphragm to lose its telephonic properties, load it with weight up to a certain limit, which may even exceed the weight of the diaphragm. These two properties were indicated in the theory of the telephone which I gave in the *Comptes Rendus* (vol. CI., pp. 744 and 1001).

3. The effects of a microphone placed in the primary circuit of an induction coil and of a telephone placed in the secondary circuit are superimposed when we act simultaneously upon both apparatus, either superimposing themselves or placing them in juxtaposition, or combining them intimately, the microphone being fixed to the membrane of the telephone.

As regards reception we may base it upon the following principle which I have indicated as regards radiophonic effects (*Comptes Rendus*, vol. CI., p. 944), a principle already applied, but incompletely.

4. When the membrane of any telephone whatever separates two air-chambers, the one without and the other within the instrument, we may receive distinctly and strongly the movements of the membrane transmitted to the air by the aid of one or more acoustic

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tubes adapted laterally to these chambers, provided we give them suitable dimensions.

In accordance with these data I have had constructed two types of telemicrophones which give good results, the one in which the telephonic and microphonic organs are superimposed and the other in which they are combined.

We easily obtain an apparatus of this latter type by the aid of a D'Arsonval telephone, to the membrane of which are firmly fixed the carbons surrounded by a thin iron cylinder of a microphone of the system of D'Arsonval and P. Bert. These carbons are in the interior of the apparatus, a small auxiliary magnet regulating their pressure upon their support.

The membrane is surmounted by a lid forming an air chamber of at most 0·01 metre in height, perforated with a central aperture covered with any thin rigid plate (glass, mica, wood, &c.) against which we speak, and by two lateral apertures to which caoutchouc tubes may be adjusted.

The electric communications are the same as in an ordinary microphone; the carbons are connected to the primary circuit of an induction circuit comprising the battery; the extremities of the coil of the telephone are connected to the outer circuit comprising the secondary wire of the bobbin.

As regards transmission, when we speak into the apparatus the iron membrane vibrates and produces simultaneously the following two main effects: 1, a microphonic effect in the primary circuit of the bobbin, consequently movements of the carbons fixed to the membrane whence result ordinary induced currents in the outer circuit; 2, a telephonic effect in consequence of the movements of the membrane in the field of the magnet whence result in the same outer circuit other induced currents which are superimposed on the former.

Although the weight of the carbons is greater than that of the diaphragm and is irregularly distributed over its surface, the apparatus acts very well as a telephone if we suppress the microphonic effect, *e.g.*, by opening the circuit of the battery; if, therefore, this suppression is produced accidentally the transmission may continue without difficulty.

As for the reception, the apparatus is reversible, since it contains all the elements of a telephone. To use it as a recipient it is sufficient to raise it to the ear. If we wish to leave it on a fixed support we make use of acoustic tubes adapted either to the lid or to the chamber formed in the interior of the instrument. Care must be taken, as mentioned above, to have suitable dimensions so as to avoid the effects of resonance, which give a sort of blur to articulate speech.

In determining these dimensions we may, without notably reducing the effects, adapt several acoustic tubes of small diameter (about 0·01 metre in diameter) to each of the air chambers of the apparatus. This enables several persons to receive at once the sounds on the words transmitted. We obtain thus a telemicrophone with multiple hearing tubes.

It will be seen, moreover, that this arrangement is applicable to ordinary telephones. I have thus, in fact, constructed telephones with 2, 4 and even 8 lateral hearing tubes, giving results capable of interesting applications.

The chief advantages of telemicrophones over ordinary microphones are the possibility of a double mode of transmission with the same apparatus, the reversibility of the transmitter which much simplifies reception; the reduction of the number of organs of microphonic stations and consequently the decrease of the total resistance of the apparatus on one and the same line. This reduction permits us to simplify the construction of the apparatus and to diminish considerably their volume.

Electrical Cons.—Why is a bad workman like a secondary battery?—Because he is so frequently discharged! When is a good workman like a bad secondary battery?—When he buckles to!

THE AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

The annual meetings of the National Electric Light Association of America were held at Baltimore, Md., on the 10th, 11th and 12th ult.

The President of the Association, Mr. Frank J. Morrison, on the 10th, took the chair, and introduced the Hon. James Hodges, the Mayor of Baltimore, who delivered an address of welcome to the Association. The following papers, amongst others, were read during the meetings:—

THE PROPER CONSTRUCTION AND MAINTENANCE OF CIRCUITS.

By Mr. E. R. Weeks.

As the subjects of underground conduit and incandescent lighting were assigned to other committees, the following notes will apply to aërial arc circuits only.

Under the head of construction may be considered line wire, supports, lamps and station connections; under that of maintenance, lines, lamps and dynamos. Since the important subject of line wire was given to another committee, its discussion is omitted.

To guard against "trouble" and to facilitate its removal, the line should, as far as possible, be in sight from the ground, and should be so placed as to be readily reached. By such construction, trouble and the cost of attendance are reduced to a minimum, and one is freed from the endless complications of housetop work, with its manifold objections, *i.e.*, rights to be begged, bought or stolen; continuous delays in removing "trouble;" costly repairs to roofs, chimneys and fire-walls; together with all the thrilling adventures of a lineman.

On some narrow and overcrowded streets it may be policy to erect iron standards; but the danger of fire and of ground shocks is so great with such supports, that those of wood are much to be preferred.

To prevent the insulations being cut by tie wires and to guard against excessive slack from stretching, poles should not be more than 100 feet apart. With the best material and good workmanship, and by paying more attention to the general appearance of the line, we may gain in efficiency and do much toward silencing the outcry against overhead wires.

Aside from the necessity to comply therewith, the rules of the Board of Underwriters should be observed, because they are founded on reason and are *generally* conducive to the interests of all parties. There *must* be a positive "cut-out" on every loop. But, instead of placing it upon the building containing the lamps to be cut off, it has been found better to provide for it a special pole or support, as near as possible, of course, to the entrance to the building, but independent of it or of any structure which is likely to be destroyed by fire. By so doing, control of the circuit is retained in the event of the total destruction of the building containing the loop. There have been instances where such an arrangement would have saved the circuit and prevented loss from rebate. Where high tension currents are employed, porcelain should not be used for outside insulation. The best insulators for this service are of hard rubber and of glass. By means of wall blocks and brackets, rubber hooks and glass insulators may be used for all outside work where it is common to employ porcelain knobs.

In entering buildings additional insulation of hard rubber tubing should be used. To avoid damage from water, have entrance holes bored upward from the outside, and let the wire run from a fixture placed below the exterior opening, so that all drip shall be away from the building. For like drainage purposes, glass insulators are to be set at an upward angle and rubber hooks pointed downward.

Lamps must be suspended by some perfect insulator; vulcanised rings being the best known to our experience. The best service is given by stationary lamps. This is especially true of outside lights. Those hung with raising and lowering tackle are more liable to wear, breakage and variable contacts than are rigid lamps; and in cold weather the tackle may become so clogged with ice as to render them inaccessible. For like reasons, when it is necessary to place the light toward the middle of the street, some device similar to the Brady mast arm will prove most satisfactory.

Hoods should be sufficiently large not only to protect the lamp from the weather, but to allow access to its works while it is in service. The conical form, since it offers least resistance to the wind, is preferable to other shapes.

Globes should be deep enough to cover the arc when the lamp is trimmed full, and the aperture at the top should be no wider than will just allow the rod and holder to pass freely.

The dynamo room should be a clean, dry, well-ventilated apartment. In no other can electrical machinery be kept in a condition to do the best and most reliable work. Let every dynamo be set on some sort of frame by means of which the tension of the belt can be easily changed, and in addition, let it be carefully insulated from this frame by blocks of paraffined wood or some other equally good insulation. Wires from the machine to the switch-board are best run either by way of the ceiling or beneath the flooring. Under no circumstances should they be laid upon the floor, where they are not only in the way, but are sure to lose their insulation through dirt and wear.

All station wires should be cased in rubber tubing as high as a

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man's head, and cables and lines connected with the switch-boards must have similar coverings to guard against short circuits, fire and injury to employés. To protect both machines and lamps, and the property of patrons, every circuit ought to have lightning arresters at the station, one on each wire.

The proper maintenance of lines requires that all other wires be excluded from electric light poles. The apparent economy of partnership poles is more than offset by the increased care required to maintain lines in good condition. Such a combined system will result in greater danger of crosses and grounds, fires will be more frequent, and the lives of men unacquainted with the handling of electric light wires will be jeopardised.

The insulation of circuits should be tested several times daily, and all lines patrolled frequently. In searching for grounds, and in repairing open circuits, much time may be saved by using a magneto. Having attached the two wires of the open circuit to the station bell box, the lineman, with a duplicate magneto, goes to the break. When the wires are ready for connection, he uses the magneto to signal the station that the current may be turned on in five minutes, or some other previously determined period. In this way a search for a telephone or a walk to the station will be avoided and rebates will be reduced.

Dirt must not be allowed to accumulate on any part of the lamp. Rods, bases, switches, contacts, bushings and globes should be kept clean, and screws well set. Rods require frequent burnishings with crocus cloth. Let there be a system of rigid inspection at varying intervals, and full and exact reports from the inspector as to the work of each lampman.

If properly tended, lamps need very little adjusting. In nine cases out of ten, adjusting simply means cleaning. But one man should attend to the adjustment of any set of lamps, and these, if properly cared for by the lampman, ought to run for a long period, with little other attention. As often as once in two years at least it is well for the lamps to be returned to the station to receive a thorough overhauling, and to be repainted that they may present as creditable an appearance as possible.

In the annual contract with the consumer there should be a clause especially stating that any working with the lamp by other than electric light employés will relieve the lighting company from all responsibility for failure of light. Employés should be provided with badges worn in plain sight.

Machines run in series do not give as good results as when run singly. The tension is increased to the danger point, while oscillation and all other kinds of trouble are more difficult to overcome.

The insulation of dynamos must be tested as often as is that of the outside circuit, and all circuit connections and binding foot screws must be kept tight.

Having given the machine the most favourable setting, it still needs intelligent attention to maintain it in an efficient condition. Except in an unusual emergency the necessity for calling an expert will generally mean that the machine has not had proper care. The insulating parts will probably be found greasy and gummy and coated with metallic dust, which destroys insulation and causes trouble of various kinds.

In conclusion, it may be said that if circuits are properly constructed and cared for, they should work satisfactorily. If they do not do so, if they are in constant need of repairs, if lamps require frequent adjustments, if bushings are continually burning out, the *meaning* is careless attendance; and of all this carelessness, failure in cleanliness will be found the most common fault. Given a well constructed circuit, cleanliness is the ounce of prevention that will obviate 90 per cent. of the vexations of electric lighting.

Mr. COOPER remarked that in Brooklyn they found that the poles were near enough to each other when 250 feet apart; certainly 150 feet, instead of 100, was quite close enough.

Mr. KING explained the operation of the system in use by his company in Minneapolis for suspending arc lamps at street intersections, running the lamps out by means of a sheave, pulley and winding drum. It was found a cheap, effective and popular system. The cost was $6½ for the apparatus.

Mr. COOPER and Mr. LINNELL both said they had met with practical opposition and objection to running lamps out across the streets.

Mr. RIDLON: The greatest objection to the stringing of lamps in this way is the liability to accident from the fall of a lamp, which weighs from 50 to 65 lbs. I have known cases where running the lamp to and fro has worn the suspending wire away so that the lamp fell, with great danger to people and carriages passing. It is strongly objected to in New England, and in Worcester they have had one or two accidents of that kind, bringing down not only the lamp but the circuit; and they have gone to considerable expense and built a sort of tramway for the lamp to run out on, capable of supporting at least two or three hundred pounds.

Mr. WEEKS contended that as the pole system involved cheaper construction and cheaper maintenance the other plans must fall to the ground. Where tackle was hitched to a house it had to be moved should the house be pulled down. He knew of a case where a man had a 75-foot derrick, and had it moving up and down until he brought the electric light people to terms. Another great and insuperable trouble with these movable lamps was the variable contacts.

Mr. SMITH, of Jamestown, N. Y., said they used a rope in connection with their lights; but it was pointed out that in practice it was found that evil disposed persons could meddle with the rope.

ELECTRICAL TRANSMISSION OF POWER.

By CHAS. J. VAN DEPOELE.

During the summer months of 1885 I entered into a contract with the directors of the Toronto, Ont., annual exhibition, to run a train of three cars and a motor car from the street railway terminus to the upper grounds of the exposition, a distance of a mile. Having only a single track, I had to prepare here for a light train and good speed. The plant consisted of the following:—One steam engine, 10 by 16, running 125 revolutions per minute, driving an ordinary 40-light (arc) machine, having an E.M.F. of about 1,400 volts and an intensity of current of about 18 ampères. The engine and dynamo were placed in Machinery Hall, close to the boiler room.

The dynamo was connected, one pole with the rails, which were fastened together by means of fish plates, and the other pole to an overhead wire, hanging over the centre of the track, by means of arms extending from poles placed along the length of the track. On top of the car, on which the motor was placed, was a contact wheel carried by a pivoted beam, the latter being provided with a spring on one end pressing the wheel at the other end up against the underside of the overhead wire. This contact wheel was in communication, by means of a flexible cable, with the switches, rheostat and motor; from the motor the current was carried to the axles of the wheels, the wheels to the track, thus closing the circuit upon the generator.

We began placing poles, &c., on September 1st, and made our first trip on September 5th. From beginning till end not the slightest hitch occurred, running regularly from 8 a.m. till 10.30 p.m. without stopping a minute. On many occasions we carried from 225 to 250 people. On one end of the track we had a 200 feet curve to start, then a level of some 2,000 feet, with two curves of about 1,000 feet radius, then a grade of some 1,500 feet, gaining gradually to about 6 per cent. The rest of the road had a downward grade to the terminus, which made it a disadvantage in starting. As above said, the distance was a mile, and the round trip never exceeded eight minutes, so that including starting and stopping, we made for part of the way at least 30 miles per hour. During the last five days of the fair we carried 50,000 people. The consumption of coal, as given by Doty and Sons, who ran the engine, was on an average of 1,000 lbs. in 10 hours.

The next step was to South Bend, Ind., where we equipped four ordinary street cars, one large open car with a 10 H.P. motor, and the other three closed cars, each with a 5 H.P. motor. The large car was run for the first time on November 14th, 1885, and was packed with humanity to its utmost capacity. Everything worked like a charm. The plant consists at present of the following:—A 50 H.P. water wheel, and two 20 H.P. generators, and, as above stated, one 10, and three 5 H.P. motors. The track is laid with the ordinary flat rail, so in order to connect the rails together we placed copper plates 3 inches by 12 inches under the joints and spiked the rails down on both sides of the track, so that there is no chance of breaking circuit. As will be understood, the rails in the present case form again one part of the circuit, the other part consists of a copper wire ¼ inch diameter suspended above the track, from cross wires fastened to poles placed near the curbstone, and at a distance of about 100 feet apart. From the under side of this copper wire or conductor hangs a carriage, fastened to a flexible cable, passing to the inside of the car, where it is in connection with the switches, the motor, &c.; this carriage travels along with the car, and makes a perfect contact. After the first trial of November 14th the 5 H.P. motors were soon in place and have worked admirably. The tracks are never perfectly clean, on account of constant traffic over the road, but since both rails are connected and also all four of the wheels, it is almost impossible to break circuit between the motor and the rails. The cars have run right along through mud and snow, and no trouble has been experienced with the circuit.

On running the four cars at once, the generators work perfectly, from 6 in the morning until 11 p.m., requiring not the slightest attention; the brushes are set in the morning, and are not touched afterwards. Every car works independently, back or forward, without interfering with the others; the division of the current leaves nothing to be desired. The only trouble we have encountered with the plant has been with some small mechanical details, such as link bolts breaking, &c. These, of course, being small matters, are easily remedied. The main point here was the electrical part, and this has proved to be an unqualified success.

The length of the present road is about 2½ miles. The other roads will be equipped as soon as the weather allows of the placing of the poles for the cross wires.

On the 6th day of October, 1885, we entered into a contract with Mr. McConnico, President of the New Orleans Exposition, to run a train of cars in the grounds, with a carrying capacity of from 180 to 200 people. This road is similar to the one in Toronto, nearly a mile long, running from St. Charles Street main entrance, along the Government buildings through the grounds, to the main building and Art Hall.

All was ready for operation for the opening day, but on account of delay in obtaining steam power, we only began running regularly on the 14th of December.

The heaviest work we have done, so far, is in Minneapolis, Minn., and that during the winter months when snow and ice are faithful companions on the track; whether invited or not, they are there, and never fail.

Before undertaking the job, I was very much afraid that electricity would not be practicable in a climate where the thermo-

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meter rises seldom above the freezing point for at least three months of the year. All my fears, however, have been removed in the past six weeks; we have ascended the grades and turned the curves with at least as much facility as the steam dummies.

The electrical plant consists at present of one 60 H.P. generator and a 50 H.P. motor. Our circuit consists of the rails for one side and an overhead copper wire $\frac{3}{10}$ inch in diameter for the other side.

In South Bend we have water power as the prime motor. We ran for the first time on New Year's Eve, 1885, and continued on New Year's Day. The water wheel had no governor, and we found it rather dangerous for the generator. As the water wheel had to be governed by hand, it was impossible to keep the speed anywhere near constant. It was decided to put a governor on before running regularly. Several trips, however, were made over the entire length of the road, giving entire satisfaction. The weight of motor is 3,500 lbs., and the total weight of motor car or electric locomotive is 8 tons. The passenger cars in use here are similar to those on the New York Elevated. In some instances we had three to four inches of solid ice on the track and broke our way through it without the least trouble; in a few days the water power will be in shape to run regularly, when we will run on schedule time.

Thus far we have demonstrated that electric railroads can be operated anywhere where the steam motor can go, and that there is much in favour of the electric motor in cold countries is very evident; there is no danger of pumps freezing up, nor of brakes becoming inoperative; no water tanks are needed along the road, nor is there any coal to be taken; in fact, there are thousands of advantages in the application of the electric locomotive on street and other railroads. Whenever water power is obtainable the economy need not be disputed, and even in the case where steam is to be used as a prime motor there will be considerable economy.

No cheaper or better plant can be expected to run light trains on suburban roads than the electric motor; as, for instance, in the Detroit road now in progress, connecting the latter city with Dearborn, a single train will be run with six large-sized street cars; the speed will be from 15 to 20 miles an hour, the length of this road is nearly three miles, and it will be in operation in a few weeks.

A similar road will be in operation early in the spring in Appleton, Wis. In this case, however, six cars will be equipped with 10 horse-power motors and run independently; the length of road is about eight miles; the speed about ten miles per hour. Water power will be used to run the generators.

The street railway in Montgomery, Ala., is now being equipped with our motors, twelve cars in all, and will be running within thirty days.

In all the above places we are using overhead conductors, which are no more of an obstruction than the ordinary telegraph and electric light wires; in fact much less, since the conductors are over the centre of the roads, so that wherever wires are allowed for other purposes, they cannot be refused for the present purposes. I do not believe, however, that overhead wires would be practical in large cities where other wires have to be buried; but in this case the electric conductors can be placed underground in conduits similar to those used for cable cars. This will be much more expensive than the overhead conductors, but it will be a permanent and practical fixture.

I feel sorry that I have not found more time to prepare some figures with regard to tests of motors and general transmission, but the above is a *résume* from practical experience and facts on the track instead of on paper. I am a solid believer in the saying that experience is the best teacher, and to all the above I have attended personally from beginning to end, and am more than ever convinced that the electrical transmission of power has not only ceased to be ephemeral, but has become a real fact and a blessing to the world. All is ready, it has only to be applied judiciously and success is imminent. Thousands of horse-power are now running waste in our waterfalls which can all be utilised to advantage, in some cases running our tramways, in others our factories, &c., giving at the same time light and cheer during the absence of old Sol.

LIGHTING FROM PRIMARY BATTERIES.

By Allan V. Garratt.

I need not tell you, gentlemen, that I have not come here to warn you against forming crude and hastily adopted notions in regard to the electrical system which I represent, for I believe that the electric light companies of this country are represented by men who do not jump hastily at conclusions, and who are not in the habit of taking things for granted; but I ask you in all fairness not to unthinkingly class our system of lighting with those inventions which periodically appear before the public with meteor-like brilliancy, claiming to do that which every scientist knows to be impossible with the materials at their disposal; companies whose exodus from the business arena is as sudden and to the uninitiated as unexpected as their advent, and in regard to whose end we must remain silent if we wish to be charitable.

Had it not been for the scholarly paper (by Dr. Moses) to which we had the pleasure of listening yesterday morning, I had intended to speak in detail of those early experiments with the voltaic current; experiments beginning with Professor Volta, of Pavia, in the year 1800, when he constructed his electric pile, followed by his *couronne de tasses*, or crown of cups, which suggested to Sir Humphrey Davy his brilliant experiment of the same year, when he dazzled the whole world by producing for the first time the electric arc. These experiments were followed by others so numerous that were I even to enumerate them, I am sure I should be imposing upon your patience. It is sufficient to say that in the years which followed, a few scientists, conspicuous among whom were Daniell, Grove, Smee, Bunsen, and Poggendorf, won for themselves renown which is historic.

I need not remind you that there are especial points of activity and stagnation in the history of all science, and that at about the middle of the present century electricians had well-nigh abandoned the hope of producing powerful and continuous currents of electricity by primary batteries, and the attention of electrical investigators was turned more especially to the theory of electro-magnetic induction, as advanced by Faraday as early as 1831, after which followed many inventions, conspicuous among which were those of Pixii, Pacinotti, Siemens, Wheatstone, and Gramme; and in this way the whole question of producing powerful currents of electricity by purely chemical means fell into the background and became looked upon as a thing of the past, and the problem of converting the heat which accompanies the rapid oxidation of fuel into motion, and from motion into electricity, became the absorbing question of the day.

The latter half of the present decade has, however, marked an epoch of remarkable activity and interest in the subject of producing powerful electric currents by primary batteries, and electricians are now working actively on this question.

In the present state of the art it is not becoming in any man to stand upon the floor of this convention and claim to do with a primary battery that which can be done with a good dynamo machine; but, as you know right well, the question is not always, how much electric light can you produce within economic figures, but you are oftentimes asked, how little light can you furnish from an isolated plant at a price which consumers will pay?

This is precisely the question which I am prepared to answer. A primary battery capable of successfully lighting for a number of hundred hours a single incandescent lamp, or, if necessary, a score of them, is not an invention to be put aside as wholly insignificant.

I speak conservatively when I say that it makes not only possible, but feasible, the electric lighting of a single house, a yacht, a parlour or sleeping car, or even a man's own private carriage. It also places at the disposal of every physician and surgeon a light always ready and requiring but little care, with which he can explore the interior of the human body. I need not suggest other uses for such a light; they suggest themselves to every one. This is a field of electric lighting which is out of the reach of the dynamo machine.

The Chemical Electric Light and Power Company, of Boston, of which I am the representative, is to day putting out plants for the purposes which I have enumerated. It controls by letters patent the use in a voltaic battery of those chemicals which alone make possible practical results.

Heretofore a battery which could maintain an electric light for twenty hours was looked upon as phenomenal. The Chemical Electric Light and Power Company have placed a plant in the New York Mutual Life Insurance Building of Boston, which gives the elevator car 300 hours of good light with one charge of battery solution. We are furnishing light at prices which we find the consumers are willing to pay.

I have intentionally refrained from going into the details of construction of our battery, or the composition of our solutions. I should not feel justified in occupying the floor of this convention for any such purpose. I wish simply to say that we have no secrets, and the structure of our battery and the chemicals which we use are at all times open to inspection. The time has gone by for any one to claim to produce electricity or electric light for the public in any way which does not appeal to the good judgment and common sense of practical men who are skilled in this particular branch of applied science.

I will not longer take your time with this matter.

In closing, I wish to say that it has been to me a pleasure to bring before the National Electric Light Association the first practical device for producing the electric light in commercial quantities and within economic figures, by purely chemical means, without the intervention of any mechanical force whatever.

LOCAL AUTHORITIES AND OVERHEAD WIRES.

On Friday, last week, a special meeting of the Torquay Local Board was held to consider, amongst other matters, the petition which has been filed by the Western Counties and South Wales Telephone Company in opposition to the Torquay Harbour Purchase Bill, and to determine thereon.

The Clerk stated that Clause 130 of the Bill proposes to empower the Local Board to make, alter and repeal bye-laws, for the prevention of danger or obstruction to the public from posts, wires, tubes, or any other appliances or apparatus stretched or placed over, across, under, or in any street, for the purpose of any telegraph, telephone, railway signalling or other purpose; and by such bye-laws to provide for the inspection and examination of any such posts, &c. In its petition the Telephone Company set forth that it had opened a telephone exchange at Torquay; that it was

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encouraged by the Improvement Committee to enter upon the undertaking, and, accordingly, has caused posts to be erected and wires to be stretched, or placed over or across certain streets within the district. It admits the propriety of the Board having the power to make examinations of posts, wires, and tubes; but holds that the Board ought not to be empowered to make bye-laws for the prohibition of the same. The Company further contends that, although it is proposed that nothing in the bye-laws shall extend to any existing works until the expiration of five years from the passing of the Act, such a provision would be perfectly futile, inasmuch as the present works cannot be made immediately remunerative, and can only become so by an extension of the system. This would involve the erection of poles and other apparatus, and the stretching of additional wires across streets included in the district. On these grounds the Company objects to the extension of the provisions of the Bill to their existing works, and submits that they would be unjust and arbitrary. A letter was read from Messrs. Batten, Proffit, and Scott, Parliamentary agents for the Bill, stating that on behalf of the Lancashire and Cheshire Telephone Company they opposed the Liverpool Bill, which contained similar provisions to the Torquay Bill; and that after considerable discussion the clauses in the Liverpool Bill were settled and accepted, not only by the provincial telephone companies, but also by the chief company in London, as the precedent of clauses in similar Bills giving control over wires belonging to private companies to local authorities. This precedent had since been followed, and they consequently advised the Board to stand by the clauses. In another letter Messrs. Batten stated that they had served a notice objecting to the *locus standi* of the Telephone Company, and that they had privately heard that the opposition was supported by the chief London Company, which was desirous of getting the clauses already granted in favour of local authorities modified as regarded the absolute prohibition of telephone wires in their districts.

Mr. BRIDGES moved that the action of the Telephone Company in opposing the Bill should be opposed by the Local Board, and that the necessary steps should be taken for that purpose.

The resolution having been carried without dissent, a small committee was appointed to watch the progress of the Bill.

NOTES.

The National Electric Light Association at Baltimore. — This meeting, which took place at the beginning of last month, was a marked success, and some of the papers will be of interest to our readers. The three matters which appeared of most pressing interest to the members, were the distribution of power electrically, the use of incandescent lamps on arc circuits, and the use of primary batteries for lighting; while the evidences were numerous throughout that the whole business of electric lighting in America has reached a period when it may be said to rest upon a solid and lasting foundation of pecuniary success. The gathering of electrical men was the largest since the Philadelphia Conference of 1884.

The Electric Light in Modern Warfare.—The fact that nearly every commissioned vessel in the Royal Navy of any importance is fitted with the electric light may be regarded as ample proof of the importance which is attached to its use in modern naval warfare by the Admiralty, as well as by many experienced officers. To the long category of the last-mentioned may be added the name of Admiral Freemantle, who, in a recent paper referring to naval warfare read at the United Service Institution, expressed himself in favour of the use of the electric light, as it prevented the officer of a torpedo boat from accurately judging distances, and, in fact, from seeing what he was about.

The Electric Light on a Steamship.—Following the wise example of the P. and O. and other large steamship companies, the Royal West India Mail Packet Company is having its steamship *Trent* fitted with the electric light at Southampton. The work is being carried out by Messrs. Siemens. It is probable that the West India Company will, provided that the present installation is satisfactory, introduce the electric light on all the steamships under its direction. By doing so it would, without a doubt, greatly conduce to the comfort of the passengers during long voyages.

The Electric Lighting Act.—Lord Rayleigh, in the House of Lords on Tuesday, introduced a Bill to amend the Electric Lighting Act of 1882, which was read a first time.

In the House of Commons on the same day, in reply to Mr. Northcote, Mr. Mundella, President of the Board of Trade, said: I am not prepared at this moment to state exactly what course will be taken with the one Bill and two provisional orders which this session seek authority, among other things, to amend the Electric Lighting Act, 1882. I may say, however, that the Government could not permit any amendment of the general law to be effected by means of a private Bill or a provisional order. The whole question is under the consideration of the Government, and will, if possible, be dealt with during the present session.

Lighting of the House of Lords.—The lighting and ventilation of the House of Lords was under discussion on Tuesday, when the Earl of Milltown remarked that it would materially add to the comfort of the House if the blaze of gas which poured down upon their lordships' heads in an evening could be got rid of.

Cost of Gas in Portugal.—A company for the supply of gas in Portugal, where the charges for that description of light are far above those ruling in other European States, and where the existing works are inadequate to the wants of the community, will shortly be brought out. The cost of production in Portugal is said to be less than 3s. 6d. per 1,000 feet, while the selling price ranges from 6s. to 8s. 6d. per 1,000. We wonder that no enterprising firm has availed itself of the excellent opening which here exists for an extensive introduction of electric lighting.

Electric Lighting of the Bar Library.—In the House of Commons this week, in answer to Mr. A. O'Connor, Mr. Leveson Gower said it was intended in the coming estimates to ask for a sum of £400 for the electric lighting of the Bar Library in the Law Courts, and as soon as the money was granted the work would at once be taken in hand.

An Electric Lighting Scheme Abandoned.—At the last meeting of the St. Saviour's Board of Guardians a report was received from the Building Committee stating that, after carefully considering the tabulated statement of tenders that had been received for lighting the infirmary at Champion Hill with the electric light, and conferring with Mr. Jarvis, the architect, on the probable cost of lighting that establishment with gas, the committee recommended that the tenders for electric lighting be no further considered, and that specifications and drawings for lighting the new infirmary with gas be prepared. The chairman said the majority of the committee were of opinion that they should have gas to begin with. If, in the course of a few years, the electric light was perfected it might be introduced, with perhaps good effect. Mr. Cooksey maintained that the electric light was an unqualified success, and urged its use on sanitary grounds. After some discussion the report was adopted.

Electric Lighting at Dalton.—At the last monthly meeting of the Dalton Local Board the clerk reported, on behalf of the Electric Lighting Committee, that numerous letters from engineers, and also from firms in relation to the supply of plant for electric lighting purposes had been read. A letter from the Board of Trade had also been read, stating that it would be necessary before depositing patterns that the Local Board should state the system of lighting proposed to be adopted:—(*a*) for incandescent lighting; (*b*) for arc lighting; specifying full details as to efficiency in, and safety of supply. The Local Government Board had written, stating that a local inquiry would be held upon the Board's application for sanction to loan. The report was, after a long discussion, adopted.

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Electric Lighting and Shipbuilding.—Palmer's Shipbuilding Company, at Jarrow-on-Tyne, intends, according to *Gas and Water*, to finish the Government belted cruisers with the assistance of the electric light. The wires are exceptionally thick, and are being laid in the most obscure parts of the vessels. The intricate nature of the work to be performed, now that the ships are well advanced, renders the most perfect lighting arrangements necessary.

The New Telephone.—In an article on "The Telephone Monopoly," the *Contractor* says that at last there seems to be some reasonable hope that the gigantic monopoly held by the United Telephone Company will have to permit the escape of one or two instruments from its clutches. Further on the article states that Prof. Silvanus Thompson, who began his researches with the avowed object of showing that Bell had not exhausted all the methods by which articulate speech can be transmitted, has perfected the "Valve" transmitter; and the United Company has in consequence come to the conclusion that the success which has invariably attended its efforts in the past, in the direction of crushing competition, might on this occasion be conspicuous by its absence. Some reference to the Valve transmitter, not altogether of a favourable character, will be found in our Correspondence columns.

The Telephone on Steamers.—Mr. Hulton, manager of the Northern District Telephone Company, writes: "I notice in your impression of February 26th, a paragraph stating that the telephone has been utilised on a steamer for the first time at New Bedford, Mass. Now the cousins across the water are without a doubt smart, and generally up to the times, but they are not always first, and we may as well take credit for it when we are first on this side of the herring pond. As far back as 1883 telephones were fitted on a steamer at Newcastle, by Mr. R. Hope Jones, on behalf of the United Telephone Company."

Music by Telephone.—The music and songs of the "Mikado" laid on from the Theatre Royal, Newcastle, are a source of continual enjoyment to the Sunderland subscribers of the Northern District Telephone Company, and during the present "snowed up" state of the inhabitants, the telephone, according to information received, becomes about the only available means of communication with the outer world.

Telephonic Communication in Case of Fire.—The Plymouth Town Council has adopted a recommendation of the Watch Committee, which, with the view of rendering more efficient the Fire Brigade service of the Borough, reported that it was desirable that arrangements should be made for establishing telephonic communication between the central and branch police station and the residence of the Borough Surveyor. It had been ascertained that the Western Counties and South Wales Telephone Company was prepared to lay the wires and provide the necessary instruments for an annual rental of £33, and the Council directed a contract to that effect to be made with the company.

Telephone Exchange for Bournemouth.—The preliminary steps in connection with the establishment of a telephone exchange at Bournemouth are now in a forward condition, and a derrick has been erected on premises at the corner of Albert Road. A number of prominent tradesmen have consented to become members of the exchange, which will connect Bournemouth with the adjacent town of Poole. The yearly subscription is based on the lowest tariff in England, which, it is believed, will be the means of inducing many private residents to become subscribers.

The Postmaster-General of South Australia.—The following brief record of the public services, &c., of Mr. Charles Todd, C.M.G., Postmaster-General and Superintendent of Telegraphs of South Australia, who read a paper on "Telegraphic Enterprise in Australasia," before the Royal Colonial Institute, recently, is taken from the Colonial Office List:—"Member Royal Meteorological Society; Fellow of Astronomical Society; Assistant-Astronomer, Cambridge, 1848; Assistant-Astronomer Royal Observatory, Greenwich, 1854; Observer and Superintendent of Telegraphs South Australia, 1855; Postmaster-General and Government Astronomer, 1871; C.M.G., 1872." Mr. Todd's name will always be inseparably associated with the establishment of direct communication with the Australian Colonies in 1872. The construction of a land line across the Continent from south to north was persistently advocated by him even before the time of Mr. J. McDouall Stuart's memorable exploration, and this great work was successfully accomplished at the expense of the South Australian Government, under the immediate supervision of Mr. Todd.

Telegraphic Facilities at Portsmouth.—In connection with the new and spacious central postal telegraph office at Portsmouth, an improvement has been effected which will, no doubt, be highly appreciated by the public. Hitherto, telegraphic messages have been handed in at the ordinary office where the postal work is transacted, and received by clerks unconnected with the telegraph department. Consequently the senders of telegrams have had to wait their turn at the counter, and as time is oftentimes most valuable under such circumstances, considerable inconvenience has frequently resulted. In order to obviate this inconvenience, a special office has been built for the transaction of the work devolving on the telegraph department. Trained telegraphists are on duty to receive the messages, and transmit them as soon as they are handed in; and by this means, while the Post Office clerks are relieved of duties which are not included in their legitimate functions, a great advantage is also gained by the public, and increased efficiency secured all round.

Telegrams to the Royal Courts of Justice.—The superintendent has issued the following notice respecting the transmission of telegrams to the Royal Courts of Justice:—Telegrams will be wired direct to the office, No. 605, in the Royal Courts of Justice, and will be delivered therefrom by a messenger into the rooms indicated. The surname, number of room, and "Courts Justice" will be the recognised address for all town messages, "London" being added if sent from a country district. No title, initials, or Christian name will be necessary, except only the latter where two officers of the same name occupy one room.

Suicide of an Australian Telegraph Official.—The *Colonies and India* states that Mr. J. Farnell, telegraph construction overseer at Tamworth, New South Wales, and son of Mr. J. S. Farnell, late Minister for Lands, has committed suicide. No cause is assigned for the act, as the deceased had been cheerful and chatty to his friends just before.

Induction in Submarine Cables.—The *Engineer* of last week says:—"We think Prof. Hughes's discoveries should induce cable companies to perceive that the time-honoured system of surrounding the conductor of a submarine cable by a protecting sheathing of twisted iron wires is electrically the very worst possible arrangement. Iron, by its magnetic properties, increases enormously the self-induction of the copper core, and therefore decreases the speed of signalling. When the first cables were laid there was some excuse for employing iron and steel for the purpose of protecting submarine cables, because no other non-magnetic metal was known which had sufficient tensile strength. But now-a-days, when there is a large number of bronzes obtainable, most of them nearly equal, and some quite equal to best steel in tensile strength, there is no reason why the practice of surrounding cables with a magnetic envelope should be continued. Another valuable lesson to be learned from

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the experiments above-mentioned refers to lightning conductors. If a solid wire offers by its self-induction twenty times as much resistance to the incipient current as a stranded cable of equal cross sectional area, then the facility to conduct quickly to earth a lightning discharge is in the latter case so much greater than in the former, that solid rods should never be used. It is a curious fact that popular opinion has for years been in favour of flat strips instead of solid rods for lightning conductors. In the absence of any scientific reason for such an opinicn, we would certainly have considered this a case of popular superstition, like many others; but now Prof. Hughes's experiments have shown that there is actually good scientific reason for an opinion which, far from being merely a superstition, was rather a manifestation of the popular scientific instinct backed by experience."

Submarine Cables and Imperial Interests.—Mr. J. H. Heaton gave notice on the 19th ult. that on going into Committee of Supply on Friday, March 20, he would move the following resolutions :—(1) That it is desirable to place the whole Naval, Military, and Volunteer Forces of Her Majesty's colonies under the immediate control of the British War authorities and the Government of England; (2) that these Colonial forces be recognised and enjoy all the rights and privileges of Imperial officers and men; (3) that it is desirable that an alternate telegraph cable entirely under the control of the British Government be constructed from England *viâ* the Cape of Good Hope to Australia and from thence up to India, so that in the event of war communication may be kept up with Her Majesty's colonial and Indian possessions should the Red Sea cable be interrupted; (4) to carry out the foregoing resolutions, it is desirable that communications be opened up by Her Majesty's Government with the Australasian Governments in order to obtain their views on the subject, and to ascertain whether they are willing to continue their present contributions for colonial defence forces if placed under Imperial control.

We think it very improbable that any such cable as that proposed will be laid for some considerable time at all events. The circumstances of ground and weather render almost necessary two cables, and a large subsidy would be required by any company embarking on the enterprise. Mr. Henniker Heaton, who was a delegate for Tasmania at the recent Telegraph Conference at Berlin, seems to propose that the working, &c., should be entirely in Government hands. This might do in war time, but would not answer in peace.

In answer to Mr. Hutton, in the House of Commons last week, Mr. O. Morgan said: I am informed that the West African colonies are to contribute £5,000 a year to the subsidy, to be paid to the African Direct Cable Company, and the Colonial Office proposes that this contribution should be divided among the four colonies Sierra Leone, Gambia, Gold Coast and Lagos, on the following scale, roughly proportioned to their revenues: Sierra Leone, £1,300; Gambia, £550; Gold Coast, £2,200; Lagos, £950. The fifth settlement mentioned in the contract is the Niger territory, but there can be at present no question of its contributing towards the subsidy, as no system of Government or Revenue has yet been established there. The contribution of £5,000 from the four colonies has been fixed irrespective of any sum which may hereafter be received on account of the Niger territory.

Is it not time that our Government should attend with a little more interest to British possessions in West Africa? The French have already got behind us on the Gambia, and in their advance from the Senegal River to the Niger they will tap all the traffic from the interior. They have already settled themselves on the Niger, where they have a gunboat; and both Germans and French are doing their best to cut us out at the mouths of the Niger. The French have also established themselves at Konakri, a little to the north of Sierra Leone, and it is well known they are actively intriguing with the native tribes surrounding the latter settlement. On the Congo we are left out in the cold. The French have already a cable to Konakri, and this facts lends some importance to their action in that neighbourhood. The trade of Bathurst (Gambia) is almost entirely in French hands.

Fatal Accidents with the Birmingham Steam Tram.—Two fatal accidents occurred on Monday on the Birmingham and Midland Tramways between Spon Lane and Smethwick. Finding the work of conveying a car too much for a single engine, in consequence of the heavy snowfall, the engine of a succeeding car was called in aid. Near the Blue Gates, Smethwick, about 10 o'clock, Geo. Wall, engine driver, was engaged in coupling the rear engine when the draw bar broke, and allowed the engine to come close, and in so doing crushed him so badly that death was instantaneous. Within ten minutes the same arrangement was being carried out about 200 or 300 yards further on, Joseph Pinnow, aged about 20, labourer, being between the car and engine coupling, when the draw bar slipped out of its place, and the engine closed up and crushed his head so as to cause instantaneous death.

Painting Electric Light Fittings.—The Lancashire and Yorkshire Railway Company is advertising for tenders for painting and varnishing electric light pulleys and fixings at Manchester and Batley. Applications should be made to Messrs. Bagshaw and Sons, engineers, Batley.

Self-Induction in Electrical Conductors.—We cordially endorse the remark made by Mr. W. H. Preece, F.R.S., who says that the paper recently read by Prof. Hughes, as the presidential address to the Society of Telegraph Engineers and Electricians, is the best yet brought before that body.

The Spiral Telephone Wire.—Notwithstanding the faint meed of praise bestowed upon this rifled or spirally-grooved wire by Prof. Silvanus Thompson at the meeting of the Society of Telegraph-Engineers and Electricians, last week, it is within the knowledge of our readers that, for practical purposes, tests showed it to be valueless as an improvement upon existing lines.

Secondary Batteries.—Respecting the note on this subject in our last week's issue, extracted from an article in the *Electrical Engineer*, M. Hospitalier writes us to the following effect:—"I have not written a single line of the report to which allusion is made; it is, therefore, impossible that I could have expressed a favourable or unfavourable opinion upon the secondary battery of Mr. FitzGerald. In fact, there has been no report. I consider the use which he has made of my name in these circumstances unjustifiable, and I beg you to inform your readers of this."

The Snowstorm and the Wires.—Mr. R. E. Hulton, of the Northern Telephone Company, writes us that in his district the weather during the past ten days, and particularly during the last three, has been of a totally unexampled description. "The oldest inhabitant," even with the aid of his usually elastic imagination, is unable to grapple with the occasion, and can rake nothing out of the dusty corners of his memory of the bad old times that will at all compare with the present state of things. It is perhaps early to boast yet, but with about 3 feet of snow on the ground it is probable that the worst of it is over, and therefore it is very satisfactory and reassuring to the managerial mind to have no reports of broken wires, even on the trunk routes, where the wires are exposed to the full strength of the storm. The snow has come at a very unfortunate time, as there are several important trunk lines under construction at present, and it is very necessary to get the link between Sunderland and Hartlepool complete with as little delay as possible, while the trunk between Hartlepool and Stockton is nearly completed.

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The Manufacture of Incandescent Lamps.—The paper of M. Felix Lucas, which may be found on page 206, probably contains items of interest to the incandescent lamp manufacturer who aims at perfecting a vacuum.

King's College Engineering Society.—At a meeting of this society on Tuesday, February 16th, Mr. Saunders read a paper on "Dynamos." The author commenced by defining a dynamo-electric machine. He then reviewed the various methods of winding, referring especially to the principles and effect of shunt winding, and also explaining the combination of series and shunt coils to obtain constant difference of potential. Mr. Saunders next described the different machines in use, taking in turn several well-known types, and pointing out the merits and details of construction of each. The author dwelt at some length on the Edison-Hopkinson dynamo, noticing particularly the improvements which it embodies, both electrically and mechanically, on its American prototype. The dynamos of the following were also described, Siemens, Crompton, Kapp, Gramme, Brush, Shuckert-Mordey, Weston, Paterson and Cooper, Joel, Parker-Elwell, Thomson-Houston, Hochhausen, and Hopkinson's Manchester dynamo. The paper was profusely illustrated by diagrams clearly setting forth the various methods of winding, and the shape, disposition, and relative magnitude of the parts of the various machines.

West London School of Telegraphy.—The partnership between Messrs. Lynd and Cronin, in the proprietary of the West London School of Telegraphy, terminated on the 18th ult., and Mr. Wm. Lynd is now the sole proprietor of the establishment.

Electric Alarms and Indicators.—Mr. Albert has written in reply to the letter of Messrs. Thurkle & Co. on this subject, which appeared in our last week's issue; but his reply contains allusions of a personal character, and, as the matter is so unimportant, we cannot give it space. Moreover, Mr. Albert is not well posted in the relations existing between Messrs. Thurkle and Co. and his employers.

The Society of Telegraph-Engineers and Electricians.—A meeting will be held at the Institution of Civil Engineers, 25, Great George Street, S.W., on Thursday, March 11th, when Profs. W. E. Ayrton, F.R.S., and John Perry, F.R.S., members, will read papers on "Economy in Electrical Conductors," and "A Note on Magnetic Resistance."

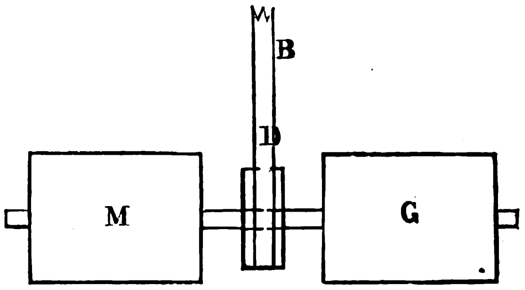
United Telephone Company's Assessment. — The *City Press* states that the United Telephone Company has appealed against the assessment of its property in eighty-six City parishes, and has obtained a reduction of the gross value from £1,000 to £740, and of the net ratable value from £834 to £625. The appellants have had to pay £20 towards the costs of the respondents.

American Papers on Electrical Subjects.—We are indebted to the courtesy of the *Electrical World* for advanced proofs of the articles which were read at the meeting of the National Electric Light in Baltimore, several of which we reproduce in this issue of the REVIEW. The papers do not, as a rule, appear to possess any scientific value, but they are practical and readable.

The Distribution of Electricity.—We have received a letter on the subject of the lecture recently delivered by Professor George Forbes before the Society of Arts. As it contains a diagram, we are compelled to hold it over till next week.

Dynamo Testing.—We shall be pleased to learn the opinions of our readers upon the method of testing dynamos as suggested by Dr. Hopkinson. It is of course well known that transmission dynamometers are not to be trusted for accurate results when used alone, but we consider that when used in combination with a Prony brake (the dynamometer when driving a dynamo at a given speed and delivering measured electrical work, indicates on its scale a certain pull, which pull can be reproduced when the Prony brake is attached to the dynamo and the mechanical work measured at the same speed), the tests may be relied upon. Moreover, unless two dynamos are at one's command Dr. Hopkinson's method cannot be applied.

The diagram shows how the two machines are connected together and driven. G represents the gene-



rator, M the motor, B the belt from the engine, and D the coupling which also serves as a driving pulley.

During the tests made with these machines a current of 521 ampères was passed through the two armatures, in order to test their mechanical strength, this current being nearly double that for which the machines are designed. The machines were found to carry this current with perfect ease, without any sparking at the brushes or displacement of the wires of the armatures. Such a current maintained for any length of time would lead to undue heating of the armature, but the fact is of importance as showing that a momentary short-circuiting of the machine would not result in serious mechanical damage to the armature, and especially that when the machines are used for transmission of power for a short time they are capable of giving about double the output required of them for regular working. In connection with locomotive power, this is a matter of vital importance as up a short incline or in starting of the cars a far greater tractive force is required than in normal working. The dynamos above described and tested are intended for the extensive new tobacco manufactory of Messrs. W. D. and H. O. Wills, of Bristol. While passing through the works of Messrs. Mather and Platt, the party inspecting the experiments, consisting of Mr. Shapcott, representing the Admiralty, Prof. Schuster, F.R.S., Mr. Webb, of Crewe, Mr. Kapp, Mr. Preece, and other scientific gentlemen, and the representatives of the technical press, were shown a large Edison-Hopkinson dynamo for an output of 50 volts 1,000 ampères at a speed of 350 revolutions, intended for electro deposition. This is probably one of the largest machines ever built for such a purpose.

We hope to have something further to say upon this matter in an early number.

Railway Electric Lighting.—A new company has been formed, under the title of the Railway Electric Lighting Company, to take over the patents and business of the Railway Electrical Contractors, Limited, which was registered with a capital of £25,000 in March, 1884. The capital of the new company is to be £130,000 in 26,000 £5 shares; 20,000 shares were offered to the public, and all of these had, we are informed, been subscribed for by the middle of the week. The terms of purchase of the business, goodwill, patents and property of The Railway Electrical Contractors, Limited, are the payment of £12,000 in cash, the allotment of 1,200 shares of £5 each of the new company, credited as fully paid up, and 4,800 shares of £5 each, credited with £2 10s. per share as paid. The vendor company, in addition to selling to the new company the existing patents for Great Britain and foreign countries, and the rights and property above mentioned, will pay all the expenses of the formation, registration, and the issue and placing of the

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capital of the company up to allotment. The light has been a much appreciated adjunct to travelling by the Brighton Company's line for more than two years past. The light is also in successful operation on the South-Eastern Railway. A testimonial from Mr. G. H. Calcraft, of the Board of Trade, is embodied in the prospectus. We wish the company success in its operations.

The Ball Dynamo.—News from America reaches us to the effect that much business is now being carried on in the States and Canada in electric lighting with the Ball system. Over 2,000 arc lamps and 100 dynamos were in use, exclusive of those in Canada, at the beginning of this year. It will be remembered that the Ball machine, from its peculiar construction, into which it apparently fell by a series of misunderstood circumstances, was looked upon as an uncanny apparatus by the majority of English electricians; one, indeed, of the highest eminence, declaring his inability to understand how it should produce any current at all. One of these dynamos was tested by the late Robert Sabine in 1883, and another by ourselves at Silvertown in the following year; the results in both cases compared favourably with those of other machines in the market. For some reasons, still unexplained, this dynamo was not taken up in England, notwithstanding the very low cost of its construction. The superintendent of the Ball Electric Manfacturing Company, writing to us on the 12th February, refers to some tests made by Prof. Anthony, of Cornell University, with a so-called unipolar machine. He says:—"He has made them, but finding so much more in the machine than he expected, wants to make still more exhaustive tests. He will do this now in a few days, and you shall have a copy of the results when received. The Ball was the first machine tested by the Mammoth galvanometer at Cornell. He made the total conversion 92·3 per cent., and the commercial efficiency 78 per cent., which, as you see, agrees well with the Alabaster-Gatehouse report at Silvertown." The data contained in this report can be found in the REVIEW for May 17th, 1884. We may, however, add that the average of three tests gave for conversion 92·33 per cent., and as energy appearing in external circuit, 78·13 per cent. These figures are almost identical with those found by Prof. Anthony.

City and Guilds of London Institute.—Following is a syllabus of Prof. Ayrton's course of six lectures at the Central Institution, Exhibition Road, S.W., on some of the industrial applications of electricity. March 12th.—"Electric Lighting." The lighting of houses, streets, trains, ships, lighthouses and large areas with arc and incandescent lamps. Cost of electric lighting compared with that of using gas or oil. Construction and regulation of arc lamps. Current, potential difference, electromotive force, resistance and electric power. Mode of measuring electric power. Cost of a watt hour. Candle-power and efficiency of lamps. Mode of measuring. Life of incandescent lamps. Most economical potential difference to use with incandescent lamps. March 19th.—"Electricity as a Motive Power."—Construction and action of an electro-motor. Starting, stopping and reversing. Power and efficiency of a motor. Mode of measuring. Effect of the speed on the power and efficiency. Action of an electro-motor compared with that of a dynamo. Governing of motors to run at constant speeds. Alternate current motors. Practical examples of machinery driven by electro-motors. March 26th.—"Electric Storage of Energy." Accumulators. Power, weight and efficiency. Mode of measuring. Life of accumulators. Use of accumulators as regulators. Use as converters of electric power supplied with high potential difference and small current into power supplied with low potential difference and large current. April 2nd.—"Electric Transmission of Power." Waste of power in the conductors. Advantages and disadvantages of the parallel system of supplying electric power. Economy effected by the use of the series, or the parallel-series system. Most economical size of conductors. Heating of conductors. Uniform potential difference or uniform current along the mains. Use of accumulators, secondary generators, and motor-dynamos, in electric transmission of power. Utilisation of natural sources of power. Practical results already obtained with electric transmission. Comparison of electric with hydraulic and wire-rope transmission of power. April 9th.—"Electric Meters." Principles employed in constructing meters to measure current electromotive force, resistance and power. Direct reading meters. Common faults in existing meters. Meters to record the total quantity of electricity, or the total amount of electric energy. Equitable modes of regulating the price of electric energy. April 16th.—"Electric Locomotion." Tramcars carrying a store of electric energy. Electric launches. Methods of conveying electric power to moving vehicles. Electric, steam, horse and wire-rope traction. Absolute blocking with electric railways. Telpherage. Probable future developments in the applications of electricity.

NEW COMPANIES REGISTERED.

Railway Electric Lighting Company, Limited.—Capital £130,000 in £5 shares. Objects: To acquire the patents, property, goodwill, undertaking and assets of the Railway Electrical Contractors, Limited. Signatories (with one share each): *Sir Daniel Cooper, Bart., 6, De Vere Gardens; *F. Green, 13, Fenchurch Avenue; *M. A. Laing, 5, Cambridge Gate, N.W.; *E. Villiers, 5, Breehin Place, Gloucester Road; F. R. E. Hersee, 50, Leyland Road; W. J. Crozier, New Malden, Essex; E. G. Farish, 24, Coleman Street. Directing qualification 100 shares. The first directors are the signatories denoted by an asterisk, and Major Charles Hy. Strutt; remuneration £700 per annum. Registered 27th ult. by Norton, Rose & Co., 24, Coleman Street.

Byng Telephone Company, Limited. — Capital £5,000 in £10 shares: Objects: To purchase and work the patented invention called the Byng Acoustic Telephone and Lee Guide, with power to acquire any other mechanical telephone or license to use the same. Signatories (with one share each): W. J. Harrison Ryder, C. Stewart Lindsay, M.E., A. F. Ball, J. P. Spencer, C.E., J. Owen-Vernon, M.E., J. H. Armstrong, all of Newcastle-on-Tyne, and J. Tennant of Gateshead. The management of the company will be in accordance with Table A of the Companies' Act, 1862. Registered 25th ult. by R. Jordan, 120, Chancery Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

West London Electric Lighting Company, Limited.—The returns of this company for 1884, 1885 and 1886, were filed on the 25th ult. The last of these, made up to the 3rd ult., shows that of the nominal capital of £60,000, in £10 shares, only 175 shares have been taken up, and upon these no call has yet been made.

William Elmore, Limited.—At an extraordinary general meeting of the shareholders in this company, held at the offices, 24 to 28, Charlotte Street, S.E., on the 17th December, several alterations were authorised to be made in the articles of association. The special resolution was confirmed on the 16th January, and duly filed on the 26th ult.

International Electric Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 13th ult., directs that the voluntary winding up of this company be continued, but subject to the supervision of the Court, and all creditors, contributories and liquidators of the company, and all other

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persons interested therein, are to be at liberty to apply to the Judge at Chambers as there may be occasion.

West African Telegraph Company, Limited.—An order of the Chancery Division of the High Court of Justice, dated 13th ult., directs the reduction of the capital of this company to £40,000, in £10 shares, in accordance with the resolution passed at an extraordinary general meeting held on 19th January, and confirmed on the 5th ult.

Simplex Electrical Syndicate, Limited. — The registered office of this company is at 9, North Street, Wandsworth, Surrey.

Continental Etève Engine Company, Limited.—At an extraordinary general meeting of this company, held at 15, New Broad Street, on the 2nd inst., it was resolved that clause 12 of the articles of association be annulled, and the following clause inserted instead : "12. The allotment of shares shall be made by the company, and it shall commence business only upon 5,000 shares in the capital of the company being subscribed for, and the sum of not less than 10s. per share being paid thereon. Simultaneously with the transfer of the patents (or such as have been already granted), to be acquired by the company under the contract referred to in article 6, or under the agreement modifying the terms thereof, and of the right to such patents as are not yet granted for countries mentioned in the agreements, the allotment of the said 5,000 shares, and the shares to be allotted in respect of the purchase of the said patents shall be made, and the regulations for the management of the company shall be in force in respect to shares subscribed for and allotted in like manner as if the whole of the shares into which the nominal capital is divided had been subscribed for and allotted." This resolution was confirmed 17th ult., and duly filed on the 27th ult.

CITY NOTES, REPORTS, MEETINGS, &c.

Telegraph Construction and Maintenance Company, Limited.

THE 22nd ordinary general meeting of this company was held on Tuesday at the office, 38, Old Broad Street, Mr. Philip Rawson presiding.

Mr. William Shuter, the manager, having read the notice convening the meeting, and the minutes of previous meetings,

The Chairman said the shareholders would regret as much as he did that their worthy chairman was not present. About an hour before the meeting was to take place, the directors received a note from him to the effect that his doctor would not allow him to go out. They had no reason to suppose that he was seriously indisposed, but, in consequence of the severity of the weather, his medical adviser thought it prudent to keep him at home. He might mention as an interesting fact that Sir Daniel Gooch had presided at 45 consecutive meetings of the company; this was the first meeting at which circumstances had compelled him to be absent. It was a much easier task to preside where a company was prosperous, and he might fairly say, he thought, that their company had been very prosperous, and upon this he sincerely congratulated them. The report and figures were drawn up exactly on the same lines as they had been accustomed to receive them, and there was really very little for him to say. The accounts showed a profit of £82,740, and adding to that £72,166 brought forward from last year, they had a total of £154,907 to be dealt with, and that enabled them to declare the usual dividend of £1 16s. for the half year, making 20 per cent. for the year, and to carry forward the substantial sum of £65,267. With regard to the operations of the year, it was within their knowledge that early in 1885 the Government entered into a contract with the company for 1,000 miles of cable. However, it was not required, but the cable was manufactured and paid for. The company also manufactured 322 miles of cable for the Government and laid it from Shanghai to Port Hamilton, a new coaling station off the coast of Korea; that was also paid for. Then 740 miles had been manufactured for the Eastern and South African Company, being the second cable laid on that section. The Heligoland-Cuxhaven cable had been partially relaid, and brass-ribboned to resist the attacks of the teredo, a little insect which caused a great deal of mischief in submarine cables. The cables connecting the Fastnet Rock and the *Sunk* lightship with the land had been successfully maintained, with slight interruptions. These were experiments, and, particularly in the case of the *Sunk* lightship, they had had great difficulty at first in keeping up communication, but their electricians and engineers had now, he believed, got over the difficulties, and at the date of the report communication with the *Sunk* lightvessel had been maintained for 306 days out of 311. In addition to what he had already stated, they had manufactured 763 miles of cable for various telegraph companies and Colonial Governments. The *Calabria* and *Kangaroo*, which had been chartered by the Government, had been discharged and both were now in the Thames. He might mention that with regard to future work, they were manufacturing 550 miles of cable for the Eastern Company, to be laid between Singapore and Penang. There was also a considerable contract pending for 2,000 miles of cable for the African Direct Cable Co. There was nothing further calling for notice, and he would move : "That the report and accounts of the directors to the 31st December, 1885, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of £1 16s. per share, in addition to the 12s. per share paid as interim dividend to 30th June, 1885, be paid on all shares of the company for the year ending December 31st, 1885, and that such dividend be paid free of income tax."

Mr. George W. Campbell seconded the resolution.

Mr. William Abbott said he was expressing the unanimous feeling of the shareholders when he regretted the absence of Sir Daniel Gooch. There was one matter respecting which the shareholders would like to hear something, but on which the report was silent; that was the important matter of electric lighting. There was no doubt that this company held the foremost position with regard to cables and everything electrical. They had done well, they had large capital, experienced officers, men of high training, eminent electricians, and therefore he was anxious to know why it was that electric lighting was standing still. Was it that Mr. Chamberlain's Bill had completely broken down this enterprise? When they heard so much about the unemployed, and when they knew of the enormous capital seeking employment, it seemed strange that such an important enterprise as electric lighting, which was making extraordinary strides in every other country, should here show little sign. He believed that if any scheme which gave the capitalist a fair chance of a return after a certain period, any amount of money could be brought into the work of electric lighting. With regard to connecting Lightships, he presumed the work was entirely in their own hands, and he foresaw that this was a branch of business where there would be great development.

The Chairman said there was no doubt whatever that the Electric Lighting Act had been a very great clog upon the electric lighting industry. With regard to their own electric lighting, they had not said anything about it because it was as yet only an experiment. The installation at Paddington was not yet open, and a great variety of difficulties had arisen, but most of these had been removed. The greatest difficulty was with reference to the residents around Paddington Station, but so far as he knew, they had all been quite quiescent for a long time. What might happen when the machinery was in full swing he was not prepared to say, but hoped everything would be straightforward and right.

The resolution was then put and carried unanimously.

Lord Alfred Paget and Mr. G. W. Campbell having been re-elected directors, and Messrs. John Gane and James Glegg, auditors,

Mr. William Ford, in moving a vote of thanks to the chairman and directors of the company, said it was some years since he last had the pleasure of attending a meeting of this company, and it was a great satisfaction to him, as it must be to his co-proprietors, to know that it had survived some of the advice which in those years ago he had ventured to give to it; and they had to thank their board of directors for rejecting much of the advice he then offered, for he feared that if they had followed some of the juvenile precepts he then endeavoured to enforce on their minds, the happy results now announced would not have been secured. Whilst recanting some of the errors of his youth, he must make candid confession that he was then most strongly in favour of the utmost publicity in the reports of the company, and of communicating to the shareholders every possible tittle of information that could possiby be given. He recanted that now as an error. Many things had happened since then; important competitive establishments had grown up for the manufacture of cables, and he ventured to say that the information contained in the reports of this company too frequently gave their competitors an insight into the working of their business which it was exceedingly indiscreet for them to give. For his own part he would have excluded from the report now before them all that portion relating to the operations of the company, and would simply have said, "Various important contracts have been entered into, and successfully and profitably executed during the course of the current year." Any further information shareholders taking an interest in the affairs of the company desired they would, he had no doubt, readily obtain from their able manager, Mr. Shuter. This was simply his individual opinion; but he believed the experienced gentlemen who sat at the board would confirm him in the view which he had expressed, that in a manufacturing business of this character, having such powerful competitors, it was not always discreet to tell who their customers were, nor what amount of work they did for them. He then moved a vote of thanks to the Chairman, Sir Daniel Gooch, whose indisposition he exceedingly regretted, and the other members of the board, whose valuable services they all highly appreciated. After the lapse of so many years, it was a great pleasure to him to see that the company still enjoyed the benefit of the very able assistance which they derived from their energetic manager, Mr. Shuter; also that

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they still benefitted by the skill and magnificent abilities—and he used that expression not as a mere figure of speech, but from knowledge of the gentlemen of whom he spoke—of Mr. Willoughby Smith, Mr. Clifford, Captain Halpin, and all the other employés of the company. All these were, in their particular posts, men of the highest honour and integrity, and he hoped they would continue their services for many years to the advantage of the company, and, he hoped, also to their own.

Mr. Newton, in seconding the vote of thanks, endorsed all that had been said by Mr. Ford as regarded this particular company, but contended that no company that had not achieved the splendid results of this company was entitled to the confidence of the shareholders to the extent that the latter should be content with the mere declaration of a dividend.

The vote was cordially agreed to, and the Chairman suitably acknowledged it, whereupon the meeting terminated.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended 31st December, 1885, and payable on the 25th inst. The books of the company will be closed from the 18th to 24th inst., both days inclusive.

Great Northern Telegraph Company, Limited.—The interest due on the 1st inst. on Series B of the Debentures of 1883, will be paid at the offices of Messrs. C. I. Hambro & Son, 70, Old Broad Street.

London Platino-Brazilian Telegraph Company, Limited.—The interest due on the 1st inst. on the Six per Cent. Debentures will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—An interim dividend at the rate of 7 per cent. per annum is now payable.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of February was 3,402, estimated to produce £2,750, against 3,225 messages, producing £2,730 in the corresponding month of last year. The receipts for the month of November, estimated at £2,250, realised £2,313

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 28th February are £2,483, as compared with £2,515 in the corresponding period of 1885. The November receipts, estimated at £3,935, realised £3,996.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 26th were £2,662, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for February amounted to £33,688, against £40,114 in the corresponding period of 1885.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of February were £1,576, against £1,442 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for February amounted to £48,814 against £61,784 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 26th amounted to £3,478.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

An ordinary general meeting of this society was held on Thursday, February 25th, Mr. C. E. Spagnoletti, Past-President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the adjourned discussion on Prof. Hughes's paper (Inaugural address) on "The Self-Induction of an Electric Current in Relation to the Nature and Form of its Conductor," was continued.

Mr. Preece said that when Prof. Hughes read his address he interpolated remarks to the effect that certain statements which he (Prof. Hughes) made were not of importance; those statements, however, he (Mr. Preece) did not consider to be trivial, and the same was the case throughout the paper. The latter had given rise to the best discussion that had been held for a very long period; facts which had hitherto been known only to the few were now known to the many. Self-induction has been a *bête noir* which it has been necessary to thoroughly comprehend and to master. In February, 1877, he read a paper before the Society on the subject of "Shunts;" the title of the paper he now considered to be an unfortunate one, as it did not properly express the subject dealt with, which was really that of self-induction. Owing to the excitement created by the introduction of the telephone at the time, attention had been diverted from the subject of the paper, and no more was heard of it. He had paid a great deal of attention to the subject of induction, and had tried to distinguish between and separate the two effects of electro-magnetic and electro-static induction. In the paper referred to, he had pointed out the similarity of the effects to those of inertia in mechanics. He had not attacked the subject from a mathematical but from an energetic point of view. When a current of electricity is transmitted through a wire, the immediate neighbourhood around it became a magnetic field, and if we had another wire in proximity to the first one, it became influenced by the field and absorbed part of the energy given out by the wire in question; the subject had been thoroughly considered by Faraday. Fizeau and Gounelle had pointed out that the speed of electricity in copper and iron wires was in the proportion of 180 to 100. An Italian *savant* had also showed that when an iron resistance is measured by rapidly intermittent currents the results were different from those observed when the current was stable; the exact cause was probably not understood by the discoverer, but Prof. Hughes had now made the reason abundantly clear. Referring again to his paper of 1877, he would point out that he had not attacked the question with reference to effects on telegraph wires, but with reference to the effects on instruments. The discharge currents were measured from electro-magnets much in the same way as discharges from a condenser were measured. Taking the discharge from one limb of the magnet of a Morse inker as unity, the discharges from two limbs were 1·7. When the cross piece was added on, the discharge rose to 496; and when an armature was also added, this was still further increased to 2,238. On joining the coils up for quantity, this latter was reduced, as would be expected, to 502. Three different forms of relays gave effects of 1,688, 279, and 26, respectively; the latter being the result obtained from the present Post Office standard pattern, in which there was no cross-piece. The result of induction in the case of telegraphy is a reduction in the speed of working, but by proper means this, to some extent, may be obviated; thus, in the case of the Wheatstone automatic instrument, the speed of working, which originally did not exceed 50 to 60 words a minute, had now been increased to 450. In telephonic communication the effect of induction was to produce muffling, and this effect was more due to electro-magnetic than electro-static induction. The result of using a metallic circuit, and also of twisting the wires, had been pointed out by Prof. Hughes. An experiment to determine the relative values of iron and copper wires had been made between London and Newcastle,* and practically the paper of Prof. Hughes had been the outcome of this. Between London, Manchester, and Liverpool four new iron wires had been erected, and in order to determine how far telephonic communication could be carried on, these wires had been arranged on the "twist" principle. The result, he was sorry to say, was that it was found to be practically impossible to speak from London either to Liverpool or Manchester; the speech being blurred and confused. If the wires had been of copper instead of iron, he had no doubt but that a very different result would have been obtained. Prof. Hughes had shown the effect of stranding iron wires, but he doubted whether all the results anticipated from the discovery would be what were anticipated, but even if they were the use of such wire would be impracticable. Stranded wire allowed snow to accumulate on it with comparative ease, it was not durable, and, moreover, its static inductive capacity was high; again, its resistance is high. The result of compounding copper with iron in wire was marvellous, and the results of some experiments on the subject would be communicated by Prof. Hughes, the copper seemed to act as a shunt to the iron, and to thus remove the self-induction. One method of getting rid of self-induction in telegraphy was by placing a shunted condenser between the receiving instrument and earth, the discharge from the condenser in this case cut off the "tailing" of the current. Sparking in relays was an effect of self-induction; this was, curiously enough, traced to the self-induction in galvanometers, which in the postal system were always kept in circuit with the line; on short circuiting the galvanometers the effect disappeared. With reference to Mr. Pope's remarks as to the joining up of relays in multiple arc, an explanation of the result had been given by him (Mr. Preece) in his paper of 1877. He might remark that the results obtained by Prof. Hughes had been effected by means of a few feet of wire only, whereas he himself had to determine them from a length of 278 miles (between London and Newcastle). He considered that Prof. Hughes's experiments had greatly added to the progress of electrical science, and that the paper was the best yet brought before the society. In this case, experiment as usual had gone in advance of theory.

Dr. Fleming pointed out that the effect of self-induction in a wire could be greatly reduced by slotting it, that is to say, by making it in the form of pinion wire.

Mr. Desmond FitzGerald drew attention to the theories which he had formed on the subject, and which had been published by him in the "Electric Telegraph Review" of 1870. He had come to the conclusion that electromagnetic induction precedes the current, and that there was a certain period at which the inducing current ceased.

Prof. Silvanus Thompson pointed out that one point in connection with Prof. Hughes's experiments seem to require clearness, and that was, that no account seemed to have been taken of the rate at which the makes and breaks were made. What would happen if, instead of a microphonic make and break, a tuning fork were used, giving, say 100 vibrations per second. He ventured to think that better results would be obtained if the makes and breaks were made in this way. The effect of self-induction could be expressed by the equation

* Electrical Review, Vol. XVII., page 271.

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$$i = \frac{E_0}{\sqrt{R^2 + 4\pi^2 n^2 L^2}} (\sin. (\theta - \phi))$$

where ϕ expresses the retardation. The retardation is equivalent to a spurious resistance, so that the actual resistance of a wire could be expressed in terms of the apparent resistance and the spurious resistance. This could be graphically represented by a right angled triangle. Dr. Flemings's suggestion with reference to the slotting of wire to prevent self-induction was correct from several points of view. The Spiral Wire Telephone Company, he would point out, had, to some extent, adopted this principle. He had himself, some time ago, pointed out that iron wire was not good for telephonic purposes. Silicum bronze would be very suitable, the wire being small, so as to have a high resistance. As regards telephonic apparatus, he considered that the receiver ought to be joined in multiple arc and not in series, with the secondary of the induction coil, the primary circuit ought also to be kept open at the receiving end. The induction coils lately designed by Mr. Langdon Davies, in which the primary and secondary wires were wound side by side, ought to be highly efficient. As regards spurious resistances, a layer of powdered carbon offered such a resistance. The principle was adopted in Varley's lightning protector, but the idea was wrong.

Prof. AYRTON said that the mutual effect of currents on each other, as well as on themselves, ought to be taken account of in considering the question of spurious resistances.

Prof. HUGHES, having briefly replied, stated that he would reserve his principal remarks and have them printed in the Journal of the society, they being too lengthy to give on the present occasion.

The meeting then adjourned.

Physical Society, February 18th.

ANNUAL GENERAL MEETING.

Prof. F. GUTHRIE, President, in the Chair.

Prof. T. H. Huxley and Mr. A. E. Mills were elected members of the society.

The PRESIDENT read the report of the council.

The TREASURER, Dr. E. Atkinson, presented his report, which was adopted.

The meeting resolved that votes of thanks be accorded to the committee of the Council of Education; the president and officers of the society; the auditors of the society's accounts.

The meeting then proceeded to elect officers for the forthcoming year, and a ballot having been taken, the following were declared elected:—President, Dr. Balfour Stewart, LL.D., F.R.S.; Vice-Presidents, Dr. J. H. Gladstone, F.R.S., Prof. G. C. Foster, F.R.S., Prof. W. G. Adams, F.R.S., Sir W. Thomson, D.C.L., F.R.S., Prof. R. B. Clifton, M.A., F.R.S., Prof. F. Guthrie, Ph.D., F.R.S.; the above have filled the office of president. Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, M.A., LL.B., Prof. H. McLeod, F.R.S., Prof. W. Chandler Roberts-Austen, F.R.S. Secretaries, Prof. A. W. Reinold, M.A., F.R.S., and Walter Bailey, M.A. Treasurer, Dr. E. Atkinson. Demonstrator, C. Vernon Boys. Other members of council, Conrad W. Cooke, Prof. G. Forbes, F.R.S.E., Prof. F. Fuller, M.A., R. T. Glazebrook, M.A., F.R.S., J. Hopkinson, D.Sc., F.R.S., Prof. J. Perry, F.R.S., Prof. J. H. Poynting, M.A., Prof. A. W. Rücker, M.A., F.R.S., Prof. S. P. Thompson, D.Sc., C. R. Alder Wright, D.Sc., F.R.S.

Prof. GUTHRIE, in resigning the position of president, thanked his colleagues for the help they had afforded him since he became president of the society in 1884; he also congratulated the society upon the highly satisfactory state to which it had attained.

The meeting then resolved itself into an ordinary meeting.

In the absence of the president, Prof. Balfour Stewart, the chair was occupied by Prof. G. C. FOSTER.

The following communications were read:—

"On Experimental Error in Calorimetrical Work," and "On Delicate Calorimetrical Thermometers." By Prof. U. S. PICKERING. In conducting a great number of determinations of the heat of dissolution of a solid body in water, the author has had an opportunity of detecting the sources of error incident on such work, and by an examination of the results has not only obtained the mean error of a series of observations, but has been able to apportionate this error to its various causes. In the experimental work it was found that the presence of anything but air between the calorimeter and jacket was most injurious; the space should be entirely open and no cover of any sort should be used. Before reading the thermometers, as pointed out by Berthelot, the top of the stem should be tapped for some time, otherwise the mercury lags behind the true temperature; but besides this thermometric error, which the author calls the "temporary error," is another effect which may be termed the permanent error, of a similar kind, which no amount of tapping will remove. He has found and verified by special experiments that a thermometer when rising is invariably too low, while when falling it is invariably too high. Error due to this, which varies in amount with different instruments, is avoided by conducting the whole experiment with a rising or with a falling thermometer. The thermometers employed in these experiments had a range of 15° C., and a total length of 600 mm. The experiments were performed at temperatures varying from 1° to 26° C., and as it was important that the same thermometer should be used in different experiments, and even advisable to use the same part of the scale of the thermometer, the following expedient was devised:—

The thermometer was first heated to the highest temperature required in the experiment, and by the application of a flame to the mercurial column, just below the enlarged space at the end of the tube, that part of the mercury above the flame was broken off and driven into the space, where it remained when the thermometer was cooled. By this means the relative value of a scale division was only inappreciably affected, while the absolute value could be obtained from a single comparison with a standard. From an examination of the results obtained, the author concludes that for further accuracy in this kind of work we must look for improvements in the methods employed, the instruments having, he believes, attained to a state as near perfection as possible.

"On Some New Forms of Calorimeters." By Prof. W. F. BARRETT. These instruments were constructed for the accurate and ready determinations of specific heats, notably those of liquids. In the first form the bulb of a thermometer is blown into the form of a cup, of about 4 cc. capacity, which thus acts as a calorimeter. Into this cup the liquid is dropped directly from a burette, its temperature being observed by a thermometer in the burette, the mouth of which is closed by the end of the bulb of the thermometer, which is ground, and thus acts the part of a stopper, so that on raising the thermometer, the liquid flows from the burette into the cup. The thermometer itself forms a balance, the horizontal stem acting as the beam is supported by a knife edge, and a pan is attached to the further end, by the addition of weights to which the weight of liquid added can be ascertained. In the second form, a simple thermometer with a large bulb is used, the latter dipping into a silver vessel into which the liquid is introduced as before.

Prof. S. P. THOMPSON exhibited a glass calorimeter, similar in construction to that of Favre and Silbermann; water is used instead of mercury, the great density of which renders it unsuitable for use in so large a glass vessel.

FEBRUARY 27TH, 1886.

Dr. J. H. GLADSTONE in the Chair.

Dr. Sydney Young and Mr. D. E. Jones were elected members of the Society.

The following communications were read:—

"The Relations of Pressure, Temperature and Volume in Saturated Vapours, by Prof. W. C. UNWIN. In the first part of this paper certain formulæ given by Messrs. Ramsay and Young in a recent communication on "Some thermodynamical relations," are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p \frac{d\,p}{d\,t}$ is constant. Prof. Unwin finds, however, that $t \frac{d\,p}{d\,t}$ is less constant than $t^2 \frac{d\,p}{d\,t}$, while $\frac{t^2}{p} \frac{d\,p}{d\,t}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that $\frac{t^{n+1}}{p} \frac{d\,p}{d\,t}$ might be more nearly constant, and the integration of this gives

$$\log p = a - \frac{b}{t^n}$$

a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations in which for convenience in calculation the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log. p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p} \cdot \frac{d\,p}{d\,t} = 2{\cdot}3025 \frac{n\,b}{t^{n+1}}$$

$$= 2{\cdot}3025\, n \frac{(a - \log. p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\frac{t}{p} \cdot \frac{d\,p}{d\,t} = 2{\cdot}3025 \frac{n\,b}{t^n}$$

&c.

These formulæ have been examined in the case of steam from − 30° to 230° C., and with pressures varying from ·4 to 20·000 mm. The constants were found to be

$a = 7{\cdot}5030 \quad b = 7579 \quad n = 1{\cdot}25$

and the differences between the calculated results and the observations of Regnault and Zeuner rarely exceeded one per cent., while generally much smaller. a, b and n have also been found for some other substances with the following results:—

Alcohol ...	$a = 7{\cdot}448$	$b = 8784$	$n = 1{\cdot}29$
Ether ...	$a = 6{\cdot}9968$	$b = 3047$	$n = 1{\cdot}153$
Mercury ...	$a = 9{\cdot}8651$	$b = 597{\cdot}5$	$n = {\cdot}69$
Carbonic acid	$a = 8{\cdot}4625$	$b = 302{\cdot}8$	$n = {\cdot}77$

Prof. PERRY offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log. p = a - \frac{b}{t} - \frac{c}{t^2}$$

which gives p in terms of t, and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the

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pressure and temperature of different saturated vapours, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.

"On a Map of the World in which the Proportion of Areas is Preserved," by Mr. WALTER BAILY. The author had devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed in 1729 for charting the stars in his "Atlas Coelestis." The construction applied to the earth is briefly as follows:—Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts, representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line; these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them; through the points so found the meridians may be filled in and the map constructed. From the method of construction it is evident that, although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rain-fall, depth of sea, ocean currents, &c.

"On a delicate Calorimetric Thermometer," by Prof. S. U. PICKERING.

Royal Society, January 21st.

"On the Clark Cell as a Standard of Electromotive Force." By LORD RAYLEIGH, M.A., D.C.L., Sec. R.S.

This paper, supplementary to that "On the Electrochemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells" (*Phil. Trans.*, part 2, 1884), gives the further history of the cells there spoken of, and discusses the relative advantages of various modes of preparation. The greatest errors arise from the liquid failing to be saturated with zinc sulphate, in which case the electromotive force is too high. The opposite error of *super*-saturation is met with in certain cases, especially when the cells have been heated during or after charging. Experiments are detailed describing how cells originally supersaturated have been corrected, and how in others the electromotive force has been reduced by the occurrence of supersaturation consequent on heating. If these errors be avoided, as may easily be done; if the mercury be pure (preferably distilled *in vacuo*); and if either the paste be originally neutralised (with zinc carbonate), or a few weeks be allowed to elapse (during which the solution is supposed to neutralise itself), the electromotive force appears to be trustworthy to $\frac{1}{1000}$ part. This conclusion is founded upon the comparison of a large number of cells prepared by the author and by other physicists, including Dr. Alder Wright, Mr. M. Evans, Dr. Fleming, Prof. Forbes, and Mr. Threlfall.

As regards temperature coefficient, no important variation has been discovered in saturated cells, whether prepared by the author or by others. In all cases we may take with abundant accuracy for ordinary applications—

$$E = 1{\cdot}435 \left\{1 - 0{\cdot}00077\,(t - 15°)\right\},$$

the temperature being reckoned in Centigrade degrees. For purposes of great delicacy it is advisable to protect the standards from large fluctuations of temperature. Under favourable circumstances two cells will retain their relative values to $\frac{1}{10000}$ for weeks or months together.

Unless carefully sealed up, the cells lose liquid by exudation and evaporation, and then the electromotive force gradually falls. Marine glue appears to afford a better protection than paraffin-wax, and there seems to be no reason why cells thus secured should not remain in good order for several years.

In cells of the H-construction (§ 29 of former paper), the leg containing the amalgam (but not the one containing pure mercury) is liable to burst, apparently in consequence of a tendency to alloy with the platinum. Protection with cement of the part of the platinum next the glass has been tried, but no decisive judgment as to the adequacy of this plan can as yet be given.

Recent cells, intended for solid zincs, have been made of a simplified pattern—nothing more, in fact, than a small tube with a platinum wire sealed through its closed end. The zincs are not recast, and the paste is prepared from (unwashed) mercurous sulphate rubbed up in a mortar with *saturated* solution of zinc sulphate and a little zinc carbonate. A stock of paste may be prepared and retained for use in a bottle.

Experiments are described tending to prove that the irregularities observed during the first few weeks of the life of a cell prepared with acid materials have their origin principally at the mercury electrode.

Cells prepared with dilute solutions have a lower temperature coefficient (about 0·00038), but would be more difficult to use as standards, whose value is to be inferred from the mode of preparation.

Details are given of H-cells charged with amalgams of zinc and mercury in both legs, without mercurous sulphate. A very small proportion of zinc is sufficient to produce the maximum effect. Pure mercury, neither alloyed with zinc nor in contact with mercurous sulphate, has an uncertain electromotive value.

Since the comparison of cells does not absolutely exclude a small general alteration of electromotive force with age, further determinations of the standard cell (No. 1) have been effected by means of the silver voltameter. The results—

TABLE XVIII.

Date.	E.M.F. of No. 1 at 15° C. in B.A. volts.
October 1883 to April 1884	1·4542
November 1884	1·4540
August 1885	1·4537

are very satisfactory, and indicate a constancy sufficient for almost all practical purposes.

Finally, some comparisons are given between Clark cells and Daniells, with equi-dense solutions, both of Raoult's pattern and of that described recently by Dr. Fleming.

NEW PATENTS—1886.

2668. "Electrical annunciators used for telephonic purposes." J. POOLE, D. SINCLAIR. Dated February 24.

2692. "Electric switch." I. PROBERT. Dated February 24.

2698. "Electric lighting." J. ROPER. Dated February 24.

2701. "Chandeliers and pendants for electric lights." W. F. STANLEY. Dated February 24.

2704. "Dynamo-electric machines." A. THOMPSON, J. G. W. FAIRBAIRN. Dated February 24.

2759. "Telephonic apparatus." D. SINCLAIR. Dated February 25.

2760. "Applying electricity for therapeutic purposes." A. H. BYNG. Dated February 25.

2773. "Voltaic batteries." A. M. CLARK. (Communicated by C. R. Goodwin.) Dated February 25.

2776. "Self-regulating electric portable battery." H. R. FISHER. Dated February 26.

2783. "Electro-motors for the propulsion of tramcars, electric locomotives, vehicles, &c." A. J. JARMAN. Dated February 26. (*Complete.*)

2785. "Safety electric lamp for coal miners." W. J. SMITH. Dated February 26.

2824. "Making carbons of incandescent electric lamps" G. DAVIDSON, R. C. JACKSON, J. B. DUNCAN. Dated February 26.

2834. "Electric signalling instruments." T. B. SLOPER. Dated February 26.

2874. "Apparatus or appliance for effecting the circulation of solutions in primary and secondary electrical batteries." J. MUSGROVE-MUSGROVE. Dated February 27.

2880. "Generation and utilisation of electrical energy." H. H. LAKE. (Communicated by G. E. Cabenallas.) Dated February 27.

2905. "Driving mechanism for electric tramcars." M. IMMISCH. Dated March 1.

2932. "Galvanic batteries." A. SCHANSCHIEFF. Dated March 1.

2956. "Electro-dynamo machines." M. IMMISCH. Dated March 1.

2959. "Electrical brushes." W. T. WHITEMAN. (Communicated by W. H. Miles and J. C. Aiken.) Dated March 2. (*Complete.*)

2975. "Dynamo-electric machines." N. TESLA. Dated March 2.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

9666. "Improvements in electric arc lamps." C. STREET and F. V. MAQUAIRE. Dated August 13. 8d. A is a disc of soft iron fixed on a rotating axle, O. B and C are two electro-magnets, the cores of which are composed of soft iron wires or strips. *b* and *c* are two soft iron armatures made of either one massive or of more pieces, and fixed on the springs, *e*, *e*; the latter are secured on the rigid blocks, E, E, E, in such a manner that the extremities of the armatures, *b* and *c*, are tangential to the disc, A. If in these conditions an alternating, an undulatory, or an intermittent current is caused to circulate through the wires of the electro-magnets, B and C, each of the armatures, *b* and *c*, under the influence of the two antagonistic actions of the magnetic attraction of the electro-magnets, and to the elasticity of the flexible springs upon which they are mounted, become possessed of a vibratory motion. The shape given to the armatures, *b* and *c*, is that of a bar, the central line of which is parallel to the direction of the vibratory motion of the springs, *e*. A polarity is, under the influence of the poles of B and C, developed at each end of the bars, *b* and *c*. The said polarities partake of all the fluctuations, resulting from the variations, the successions or the changes in the direction of the currents circulating through the electro-magnets, B and C. The polarities thus developed in the bars, *b*, *c*, simultaneously produce

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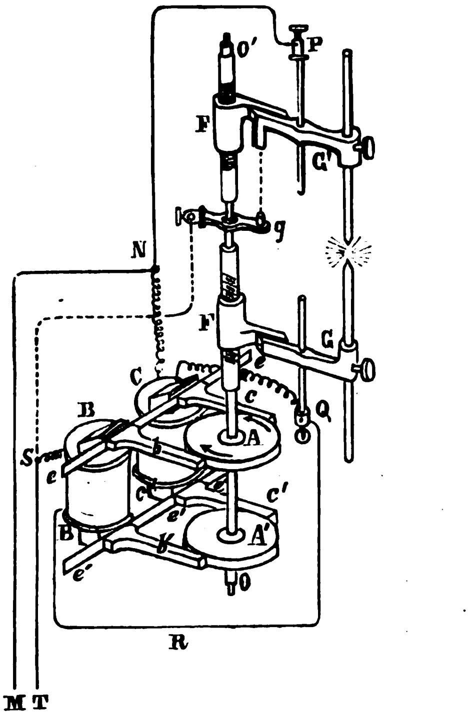
the following effects :—1. The magnetic adherence to the disc, A, and tangentially to the said disc, of the free ends of the armatures. 2. The motion of the said armatures towards the poles of the electro-magnets. A backward motion of the armature succeeds that of attraction during the period of decrease or of cessation of polarity in the electro-magnets. The adherence of the armatures to the disc then ceasing, the springs, *e*, bring them



back to their initial position without causing any motion of the disc. The result of these effects is an action, the tendency of which is to actuate the disc, A, in the direction of the arrows shown in the diagram.

12181. "An electro-magnetic revolution counter, specially applicable to ships' logs." B. FAYMONVILLE. Dated October 13. 8d Relates to a speed register, the registering of which is produced by an electro-magnetic apparatus.

12551. "Improvements in regulating apparatus for electric arc lamps." G. E. VAUGHAN. (Communicated from abroad by the Austrian Small Arms Manufacturing Company, of Austria.) Dated October 20. 8d. Consists of improvements in electric arc lamps constructed as described in the complete specification of an application for Letters patent made on the 26th day of November, 1884, No. 15566.

13451. "Improved method of neutralising the residual magnetism in electro-magnets." E. G. COLTON. (Communicated from abroad by F. Haenichen, O. Haenichen, and O. Seebas, all of New York). Dated November 6. 8d. The invention consists of a method of neutralising the residual magnetism in electro-magnets by the following steps:—firstly, sending a current in one direction through the coils of the electro-magnet so as to attract the armature; secondly, sending a current in the reverse direction through the coils of the electro-magnet, so as to neutralise the residual magnetism of the cores and cause the dropping of the armature and the automatic breaking of the circuit when the complete neutralisation of the residual magnetism has taken place.

13575. "An improvement in the art of conveying articulate speech by electricity and in apparatus for that purpose." H. J. ALLISON. (Communicated from abroad by A. M. A. Beale, of New York.) Dated November 9. 8d. Consists chiefly in the use of condensers placed at each end of the main line circuit.

13998. "Improvements in electrical incubators." H. J. ALLISON. (Communicated from abroad by C. Bassini and A. Heyden, both of America.) Dated November 17. 8d. Relates to an electrical device for maintaining constant temperatures in the incubator; and contains a mercurial thermometer combined with mechanism and a damper, which damper is suitably arranged in the incubator to allow, when opened, of the escape of hot air therefrom. The mercury in said thermometer on rising to the predetermined points closes an electrical circuit, which includes a magnet, and the said magnet through its armature controls the damper. The invention also consists in the improved mechanism for turning the eggs without necessitating access to the interior of the box, and in the novel construction and arrangement of the heating and air moistening apparatus.

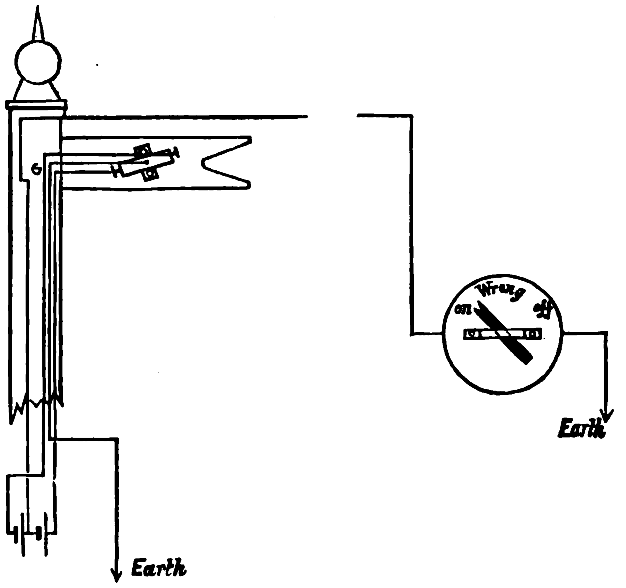
14148. "A combined electric bell and pendulum indicator." A. F. LLOYD. Dated November 18. 6d. Consists in combining the indicator with the bell, and thus rendering the use of a separate indicating apparatus unnecessary.

14851. "Improvements in and relating to lightning conductors." R. P. EIDSFORTH and F. J. MUDFORD. Dated December 3. 8d. Has reference to the means of uniting the parts of the lightning conductor together, and of securely attaching it to the building or structure to be protected from the effects of lightning.

CORRESPONDENCE.

Railway Signalling Instruments.

Can you afford me space in your columns to describe a new electrical contact maker I have recently invented for use in connection with railway signal repeaters? It is designed to be actuated by, and to record the actual position of, the signal arm or lamp, as the case may be, being quite independent of any rod or other attachment for working the signal. In the case of a semaphore signal, the contact maker is placed upon the arm itself, about midway, and securely bolted thereto, three wires are led from it along the arm to the post, and thence, one to the positive pole of a two cell battery, one to the negative pole of ditto, and one to earth. The earth wire is connected to the contact maker by means of a simple slip connector, which, in the event of the arm carrying away from the post, would draw out, thus causing an interruption in the electrical circuit, and making the repeating instrument in the signal cabin show that the arm was "Wrong." The "On" and "Off" signals are sent by the motion of the arm causing the contact to change its position from one end to the other in the contact maker, according as the arm moves up or down, and so sending the corresponding signal to the repeating instrument in the cabin by means of reversal of current.



The advantages claimed are, firstly, that the contact maker is in its proper place, *i.e.*, on the semaphore arm, and consequently registers correctly the "actual" position of that arm; whereas, in the majority of contact makers, the motion for making contact is obtained from the rod and indicates only the position of the rod, which in the event of a rupture in the mechanism, may be quite the reverse of the arm; secondly, the contacts are maintained in a clean and good working condition, being hermetically sealed, and protected from the weather; thirdly, there are no mechanically moving parts to break, wear, or get out of order. Further, the battery power being at the post, you are enabled to send reversals of current on the one line wire. By winding the coils of the repeater instrument to a high resistance, a very small battery power is made available, so avoiding all risk of oxidation of contacts, and considerably prolonging the life of the battery, and reducing the cost of maintenance.

I may add that these contact makers have been

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working under my supervision on the District Railway for many months without a failure, and that a two cell battery working on the same principle, has been in continuous use for upwards of twelve months without renewal.

I shall be pleased to give further information or answer enquiries on the above.

C. Brown.

Telegraph Department, District Railway,
Victoria Station,
February 23rd, 1886.

Incandescent Lamp Tests.

The Swan Company state that their lamps have an efficiency of 3½ to 4 watts per C.P., but do not state whether this is for lamps of low or high E.M.F.

In Messrs. Woodhouse & Rawson's new pamphlet on incandescent lamps, I notice that they state their low resistance lamps require 2½ watts to the candle power, and their high resistance lamps 3 watts per C.P.

I would be glad if some of your readers could give me the benefit of their experience in the use of lamps of different electromotive forces between 50 and 100 volts, which I take to be representative of high and low E.M.F., and which are no doubt of a different efficiency according to the E.M.F.

In the Vienna tests, in which the efficiency of the Swan lamps was not published, I notice that the Woodhouse and Rawson lamps of low E.M.F. were said to be 2¼ watts per C.P., whilst in the tests of the Franklin Institute, their efficiency per spherical C.P. (the above-mentioned candle-power being measured horizontally, and candle-power of incandescent lamps being usually spoken of as horizontal) was 3½ watts. With regard to the latter tests, I believe that the lamps were of an old make, and that there was some mistake about them, the efficiency considerably improving after the first few hours' running. With regard to the Vienna tests, where the efficiency of the low E.M.F. lamps was 2¼ watts per C.P., I suppose that Messrs. Woodhouse & Rawson have found it answer better to increase the length of life of the lamps and lower the efficiency. What I would like to know, would be, taking the life of an incandescent lamp at 1,000 hours, is the efficiency of low and high E.M.F. lamps the same, and if not, what would be the efficiency of either Swan or Woodhouse & Rawson lamps of say, 50, 60, 70, 80, 90, 100, 110 volts?

Incandescence.

Sudenburg-Magdeburg, den
Westendstrasse 27,
February 25th, 1886.

Lightning Conductors and Professor Hughes's Discoveries.

It would be of much service to lightning conductor manufacturers and the public if, before the interest manifested in Professor Hughes's discoveries dies out, some more definite expression of opinion regarding conductors were announced. I therefore venture to ask, if stranded iron wire is so good, what is the real position with regard to stranded copper wire as conductors?

Of late years copper tape has been much favoured by the public, and makers of the old and patented forms have adapted their wares to the popular taste. Now, however, there is the scientific value to be added thereto, which will doubtless do much to make permanent that form, though progress in lightning conductor knowledge is slow, as witness the number that even now are fixed *with insulators*. One form of conductor, however, most strongly recommended by a high scientific authority—Mr. W. H. Preece, F.R.S.—is emphatically condemned, viz., the iron rod of No. 4 wire.

Professor Hughes's deliverance on this subject, if he could spare the time, would be appreciated by

Copper Tape.

27th February, 1886.

Telephone Patents.

Permit me, in reply to Mr. W. J. Barnard's letter in to-day's issue, to say that when I wrote my previous letter I was fully aware of the telephone instruments of Professor Thompson, as supplied by the New Telephone Company, Limited, and it was because of the fullness of that knowledge, based upon practical acquaintance, that I expressed myself as I did. But let me refer to that experience. Last year a most influential firm, who had a number of Gower-Bell telephones in use, were desirous of adding to the number of their speaking instruments, and as the Valve telephone was in the market, it was decided to give it a trial. Two complete sets were received from London, and an expert followed, who, with the help of a man placed at his disposal, fitted them up, placing a set at either end of a well-insulated short metallic circuit. When he announced that all was completed and ready for trial considerable interest was manifested, and everyone anticipated the best of results. Unfortunately, the reverse is what happened. The speech was irregular and squeaky, and during the three days of the expert's presence no good talk could be got. He was disappointed, he said, but failed to improve it, finally leaving for London. To assure ourselves that the batteries and line were in good order, a United Telephone Company's set was placed side by side with switches to cut in either set of instruments; and, whilst the Bell-Blake gave good results (as did also a Gower-Bell), the others remained in the same unsatisfactory condition, described by an experienced electrician as "Punch and Judy talk." Need I add the result, viz., that whilst the order for new telephones was forwarded to London, it was not addressed to the New Telephone Company, Limited. I therefore consider that since a diaphragm acts so well in the Blake, and the want of it is so apparent in the instruments referred to, the point to be aimed at is to get an efficient transmitter, which yet is clear of the "combination" of a "diaphragm with a current regulator."

Combination.

February 27th, 1886.

With reference to the letter on the above subject in your issue for Feb. 19th, it would be interesting to know what "Combination" means by the term *current generator*.

An ordinary Bell telephone when employed as a transmitter, generates its own currents, or more accurately speaking, converts the energy exerted by the speaker and communicated through the medium of the atmospheric sound waves to the diaphragm, into electric currents, but anything of this nature would obviously be subject to the Bell patent.

Moreover, magneto transmitters are not sufficiently powerful to be of commercial utility, and your correspondent himself admits as much.

In Edison's specification No. 2909, 1877, will be found a description of a transmitter operated by the vibration of a diaphragm of vulcanite in proximity to the face of a thermopile, but it is most doubtful if ever passable results could be obtained with an instrument on this principle, even under the most favourable circumstances, in consequence of the extremely low E.M.F. developed by thermo-couples, and the slow action of all thermic effects.

Bréguet's capillary telephone is also the combination of a diaphragm with a current generator, and there are others of a similar nature; but I have, I think, said enough to prove that your correspondent's suggestion is scarcely so fresh a departure as he apparently imagines.

While on this topic, allow me to express a hope that you will see your way to give as full a report of Mr. Justice North's judgment in the "Bassano" case, which I see is now shortly to be published, as you gave of the proceedings of that very interesting trial.

"Telephonist."

February 28th, 1886.

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Secondary Batteries as Regulators.

It has at various times been stated that the most perfect regulator one can have to correct the disadvantages brought about by irregular motive power, is a secondary battery of suitable size, coupled in parallel with the dynamo. This statement is no doubt, broadly speaking, true, but it has been my experience that under certain circumstances the secondary battery does not absorb the excess of current produced by an irregularly driven dynamo; it is, on the contrary, forced through the lamps, causing them to pulsate in time with the variations of speed of the dynamo.

The phenomenon, however, only occurs when the amount of current being discharged exactly equals the average charging current. In my case, an ammeter inserted in the charging current circuit oscillates between 45 and 55 ampères; as the discharge approaches 50 ampères this variation decreases, and when the discharge reaches 50 the ammeter needle steadies considerably, but still oscillates to the extent of one or two ampères; at this moment the E.M.F. drops about 5 per cent., the variation of current indicated by the ammeter is forced through the lamps, and a most disagreeable pulsation commences.

Immediately the discharging current decreases or increases, the E.M.F. recovers; the ammeter shows the usual oscillation, and the lamps burn as steadily as can be desired.

If any of your readers will advise me as to the best method, if any, of overcoming this difficulty, I shall be obliged.

Aug. J. Littleton.

Sydenham.

Incandescent Lamps as Telephones.

In the course of Prof. Dolbear's lecture on the telephone, printed in your issue of February 19th, reference is made to the fact that an ordinary incandescent lamp will act as a telephonic receiver.

I should be much interested to learn when, and by whom, this was discovered in America, for I constructed receivers on this principle as far back as the spring of 1882. Later in the same year, I also found that a Leyden jar, likewise referred to in the lecture, would receive. I communicated my discovery regarding the incandescent lamp to Mr. G. J. Somerville at the time it was made, who, I find, not only recollects the circumstance perfectly, but made a note of it in his memorandum book. The fact was also known to a workman who assisted me with the experiments. In corroboration of the Leyden jar discovery, I may mention that Messrs. Woodhouse and Rawson made me, for experimental purposes, twenty special Leyden jars, which they knew by the name of "vacuum condensers." I have occasionally mentioned to my friends—Colonel R. R. Jackson amongst others—that I was in possession of a novel telephonic receiver, but without (except in Somerville's case) making known the principle, for I was not without hopes of eventually evolving a practical telephone. Pressure of business has compelled me to let the matter lie for the last three years, but I believe this could be done if earnestly gone about.

A. R. Bennett.

90A, George Street, Edinburgh,
March 1st, 1886.

A Telephone Conference.

I have spoken to a considerable number of gentlemen of many nationalities interested in the telephone, *but outside the monopoly*, as to the advisability of holding a conference in London or Paris, to discuss the telephone in general, investigate claims, and consider what steps, if any, it will be advisable to take to protect the public and the electrical profession against the present monopoly, and all agree that such a conference is most desirable, and have promised to give it all the support and assistance in their power. As it is impossible to communicate or see everyone personally, I shall be glad to receive a line from all who are willing to assist with advice or information, or who would be desirous of attending the conference. Suggestions will be thankfully received.

W. E. Irish.

Rosemount Lodge, Richmond, Surrey,
1st March, 1886.

FitzGerald Secondary Batteries.

The statement quoted from the *Electrical Engineer* in your last issue (p. 194) that M. Hospitalier had written a report upon this battery (from whatever source it may have been obtained) is incorrect. I have been present at most of the experiments made, and am fully cognizant of what has taken place. A first battery was tested in June last by M. Hospitalier, a second test took place in October, a third on the 15th and 16th December, and a fourth on the 23rd and 24th December, this last one with a rate of discharge of 22 ampères. No report, however, was given by M. Hospitalier, and no one is authorised to state that the report of the tests is or will be favourable. It is not probable that M. Hospitalier will give his report until two more electricians, one English the other French, have tested again the batteries which lay idle at the laboratory of the Eish Municipale de Physique et de Chimie Industrielles, in Paris.

The *Electrical Engineer* will not be surprised that the proprietors of the FitzGerald battery *have shown their battery in France with a view to its being reported upon by a French savant*, when he knows that the Continental patents for this battery were offered for sale many months ago in Paris, where the intending purchasers are quite entitled to have the experiments conducted by their own tester.

The few persons who were present at the experiments were allowed, by the kindness of M. Hospitalier, to have a copy of the readings, but none of them were authorised to make use of the figures or to publish the results obtained, and the only thing I would say at present is, that on the 24th December, 1885, the rate of discharge was 22 ampères, and that it is intended to run a battery next time at the rate of 40 ampères.

A. F.

Spiel's Petroleum Motor.

I notice in a recent issue of the ELECTRICAL REVIEW an article on "Spiel's Petroleum Motor," and should feel obliged if you would send me the address of the agents or makers for this country.

Thanking you in anticipation,

George R. Cook.

Club Garden Road, Sheffield,
February 27th, 1886.

[Spiel's petroleum engine is being introduced in this country by Messrs. Crozier & Co., of 1, Leadenhall Street, E.C.—EDS. ELEC. REV.]

New Pattern Reversing Key for Single Needle Instruments.

Upon page 64 of Williams's "Manual of Telegraphy" (lately issued), is an engraving of a new pattern reversing key. I should feel obliged if some one will tell me how to connect it up with a pair of needle instruments on *open* circuit. With the connections as per instructions given with the engraving, the circuit is only complete when the current from the sending station passes through the battery at the receiving station. This, I feel sure, should not be. A rough sketch will oblige

"Perplexed."

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 433.

THE WEST AFRICAN CABLE.

THE debate in the House of Commons last week, on the subject of the West African Cable, must have left on the minds of the vast majority of those who read the reports something akin to astonishment that charges made with such directness and apparent sincerity as those urged by Mr. Henniker Heaton against the contracting parties in the laying of the cable under discussion, should be allowed to pass with so slight an explanation as that vouchsafed by the past and present Secretary of the Treasury. Either the contract was or was not a dishonest one, and in either case the unequivocal language used by Mr. Henniker Heaton demanded more attention than it appears to have received. Mr. Heaton may possibly be to blame for not having communicated the evidence which he claimed to possess as to the irregularities he alleged had taken place in the conduct of the affair; and indeed it seems strange that he should have withheld mention of it until so late an hour in the proceedings, when the final stage of the contract was on the point of being passed. We can scarcely wonder that the House refused, on the slight evidence before it, to withhold its sanction to a contract which was supported so strongly by the representatives of three Governments; but it will be strange, indeed, if we have heard the last of this matter. We do not imagine for a moment that it was on the part of the Government officials that Mr. Henniker Heaton alleged or suspected any grave departure from rectitude in the conduct of the matter, but the character of persons holding semi-public positions was gravely and directly assailed during the course of the debate, and we can scarcely believe that those persons, if they have any regard, as they assuredly must have, for their reputation before the world, will allow the matter to be quietly dropped. We have in previous numbers of this journal called attention to circumstances which appeared to us in the light of peculiarities in connection with the laying of this cable, and now more than ever an explanation seems to be demanded of the whole history of the enterprise. No one is more capable of giving such an explanation than Mr. John Pender, but had not his name been mentioned in such unpleasant terms in the House of Commons, he would have been the very last person to whom we should have looked for it. He must now, however, feel called upon to say something.

West African Telegraph Company, Limited.—In our notice of this company in "Official Returns" last week, it was erroneously stated that the capital of the company was reduced to £40,000 in £10 shares. The figures should have been £400,000, divided into 40,000 shares of £10 each.

AMERICAN TELEPHONE PATENTS.

A CORRESPONDENT has referred in his letter, in another part of this issue, to the published opinions respecting the case which is now agitating telephonic and legal circles in America of a prominent American, whose letter in a New York paper our correspondent has forwarded us. The person referred to is Mr. George Ticknor Curtis, who consumes two closely-printed columns in explaining the circumstances attending the bringing of suit by Government for the vacation of the Bell patents, with the view of showing that the conduct of the legal officers of the Government has been entirely blameless. In this endeavour he seems to succeed, for he points out that Attorney-General Garland was in entire ignorance of what was done in his absence by the Solicitor-General, Mr. Goode; that Mr. Goode, when he gave instructions in the first place for the bringing of the suit, had no knowledge of the fact that the Attorney-General was interested in the matter, and that the action of the President in directing the abandonment of the first suit and the enquiry before the Secretary of the Interior was solely caused by his belief that the matter was of sufficient importance to bring it into compliance with a rule of administration, that when anything out of the common course was to be done by the Department of Justice, the head of the other Department primarily concerned should first act upon it. Then he says:—"However problematical it may be, whether the United States can, under existing laws, maintain any suit to repeal or vacate a patent for a useful invention on any ground that could be pleaded by an individual when sued for infringing that patent—and to me it seems very doubtful—yet I can well understand how Mr. Lamar came to authorise or advise such a suit in reference to the Bell patent. In the first place, there are a certain number of precedents for it; and although those precedents do not exactly fit the present case, they are sufficient to warrant the Executive in all executive action that has been taken, namely, to refer it to the courts, and ultimately to the Supreme Court, to determine, first, whether the United States can maintain the suit, and, secondly, whether, supposing the suit to be well brought, the Bell patent is valid or invalid." In conclusion we may say that Mr. Curtis has no high opinion of the value of the stock held by Mr. Garland in the Pan-Electric Company.

Railway Carriage Lighting.—"Dogberry," writing in Wednesday's *City Press*, says:—"I am told that on the Great Northern Railway some half-a-dozen different lights are used—all of them bad, and some simply intolerable. The change from a Northern to a North London carriage, which is invariably lighted with gas, is remarkable in the extreme. Passengers have been complaining of the "Northern lights" for years. It is hardly creditable to a great railway company that a nuisance like this should be so long suffered to continue. I shall be glad if any correspondent can give me some "light" on the subject of railway illumination." Why does not "Dogberry" "interview" the Railway Electric Lighting Company, Limited?

B

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FALL OF ELECTROMOTIVE FORCE WITH DISCHARGE OF A BATTERY.

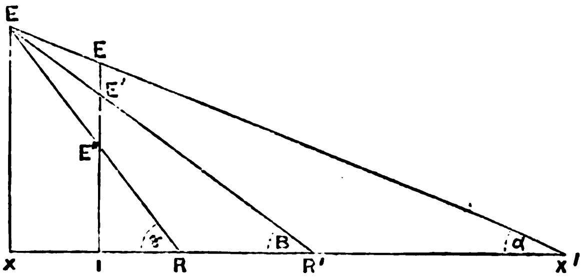
DR. LODGE, in a recent number of *The Engineer*, writes Dr. Paget Higgs, pointed out a difficulty that beset the student in experiments with batteries, and explained one of those practical phenomena of which the reason why is not always apparent *prima facie*. I would like to add some remarks about the discharge of batteries, with regard to a stumbling block that I have found a good many tripping over.

It is customary to give the electromotive force of a battery as obtained on open circuit. This for comparison is sometimes serviceable, but practically the figures have little value. What the practician (to borrow a word from our French neighbours) requires to know is the electromotive force when the battery is producing current. This is frequently a very different result, as many a poor amateur has found to his cost. It is not at all an unusual thing in an amateur's calculations for him to take the electromotive force on open circuit as the working electromotive force, and then for him to find that his incandescent lamps (an amateur generally fails here) are only red hot instead of white hot. And I am sorry to have to say it, but not always is this oversight confined to the amateur.

The best batteries are considered impolarisable (another word from the French, but perhaps we have left them too long in possession of the field), that is, the hydrogen evolved at the positive electrode is supposed quite consumed in the reduction of a metal, or by its oxidation or chlorination. If this consumption is not perfect, an unknown factor is introduced into our problem, and one that no economist will allow. However, all batteries *are* polarisable at a certain limit, where the production of hydrogen exceeds either the rate of contact of the consuming material, or the capacity of that material; in the latter case the battery is said to be exhausted; in the former a larger cell generally avoids the difficulty, or a larger surface of positive electrode. Yet this point is sadly neglected in nearly all battery construction. There is scarcely an ordinary form of battery in the market in which the positive electrode and amount of hydrogen-consuming material are not too small, with relation to the surface of zinc, to produce the best results. This, then, is the constructive difficulty, that does not, however, beset the amateur unless he builds his own battery; it is, however, a trade oversight.

Supposing a properly constructed battery, there is yet another obstacle, and this is the one to which I refer as commonly neglected—the unavoidable and inherent internal resistance. Him who doubts my statement as to this neglect I would refer to the columns of any of our technical papers, where teem inquiries as to failures to light incandescent lamps with such batteries as the Leclanché, intended for a totally different work. Even when, too, the amount of this resistance is understood by the student to depend upon size and upon distance apart of the electrodes, I have known failure to be incurred in the attempt at reduction of resistance, by bringing the electrodes so close together as to prevent circulation of a sufficient amount of the hydrogen-consuming material. With accumulators it is not at all uncommon to have the plates too close together to admit of the bulk of sulphuric acid necessary for the proper formation of sulphate; the space having been reduced with the single view of reducing the internal resistance of the cell. But the internal resistance of a battery varies also with the liquid employed, and with so many other causes as to prevent generalisation. What has to be now attempted is the explanation of the effect of this resistance.

Any explanation that can be referred to a geometrical consideration has an advantage in being apparent to the physical eye, as well as to the mind's eye, to which alone figures and symbols appeal. Therefore let X, I in the horizontal line, X, X^1, represent the internal resistance of the battery, and let I, X^1 be the resistance of the voltmeter. The vertical line, E, will be taken to represent the internal electromotive force of the battery, and then the line E^1 at the other extremity of X, I will be the electromotive force at the terminals of the battery when only the voltmeter is in circuit. Let us now set the battery to work on a resistance represented by I, R, and we see that the line joining E and R—corresponding to the line joining E, X^1 when only the voltmeter was in circuit—now makes a greater angle with the horizontal line of resistance, and cuts the line giving the electromotive force at the terminals at E^{11}, which is now the electromotive force



appearing on the voltmeter or, if I, R represent lamp resistance, at the terminals of the lamps. If I, R^1 be the lamp resistance giving the electromotive force, E_1, proper to the requisite brightness of the lamps, then, although we have a greater angle, γ, than at β (B)—the currents are proportional to the tangents of these angles, not to the angles themselves—and a greater current flowing out with the lesser electromotive force, E^{11}, the lamps—in parallel—have not each the electromotive E_1 at their terminals necessary to drive the proper current through them. With the highest electromotive force we have the lowest current, tan α.

This little diagram based on the simplest reasoning shows at once the fallacy of giving the electromotive force without the corresponding current.

ELECTRIC LIGHT REGULATION.

ON Tuesday and Wednesday last week a number of gentlemen interested in electric lighting were, by the kindness of Messrs. Robey & Co., of Lincoln, privileged to inspect the installation which was completed some months since at Muncaster Castle, the residence of Lord Muncaster, Lord Lieutenant of Cumberland. The work was carried out by Messrs. J. Edmundson & Co., of Westminster and Dublin, and has been in successful operation during the winter. The current is generated by a pair of Elwell-Parker dynamos driven by a Robey semi-portable steam engine of 16 H.P. nominal with all the latest improvements, a type of engine admirably adapted for general electric lighting purposes. This engine is fitted with one of Mr. Richardson's electric governors constructed with an improvement suggested by Mr. R. H. C. Nevile, by which the E.M.F. is kept constant under any variation of load or of boiler pressure. The regulator consists of a double solenoid within which works a double core with cross-piece at the bottom to which is linked the long arm of a lever of which the short arm presses downward upon the spindle of a valve controlling the admission of the steam to the steam chest. For incandescent lighting in parallel the wire on the bobbins is placed in shunt circuit between the main leads, and the size of wire used adjusted according to the E.M.F. which it is desired to maintain between the mains, so that when the E.M.F. is at the right point, the cores are suspended within the solenoids by their attraction. The resistance of the solenoids being fixed, any increase in E.M.F. causes an increased current to flow through them, whereby the cores are immediately attracted with an increased force, and are caused to move upwards, thereby so acting upon the lever as to close the valve until the E.M.F has been brought down again to its normal amount. There is also an attachment by which any accidental severance of the main lead would cause the stoppage of the engine. Under every kind of trial

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this regulator worked with the most satisfactory promptness and efficiency.

Both the steam pressure and the load were varied in every possible way, the regulator never showing a variation of more than 2 or 3 volts in the E.M.F., nor in the case of the most sudden changes, such as switching on or off the whole of the lights, taking more than 3 or 4 seconds to right itself; and this without the least tendency to overrun or "hunt." The great advantage gained in the shape of lengthened life of lamps is of itself sufficient to render the use of such a regulator a decided economy in the case of every installation on the incandescence system.

In a paper read by Mr. Richardson at the Lincoln meeting of the Institute of Mechanical Engineers, he pointed out the advantage of using such a regulator in connection with a compound engine in the following words:—"A compound engine may be a very economical motor when developing, say, 50 H.P. at 150 revs. per minute, while it would be exceedingly wasteful if called upon to give out only 5 H.P. at the same speed. But if the speed can be reduced in proportion to the load, bringing it down to 15 revs. per minute, the pressure and distribution of steam would remain the same; and each stroke of the engine would be delivered with the same economy as when developing the higher power, with the further good result of saving nine-tenths of the friction. The electric regulator enables this desirable result to be obtained."

The total number of lamps, which are of the Edison-Swan 16 C.P. (100 volts) type, is 180, and they are distributed throughout the house, stables and offices. Many of them are fitted into antique sconces and standards, with which they harmonise better than might at first be expected. Some lights in the corridors and on the staircase in Moorish pendants look remarkably well. In the library Messrs. Edmundson and Co. have put in an elegant electrolier of their own make, and in the billiard room have adopted a very effective arrangement of the light. By the use of accumulators the working of the machinery is dispensed with on Sundays, and the regulation in every way rendered as perfect as possible. It is interesting to know that Messrs. Edmundson & Co. find plenty to do in the special branch of electric work to which they devote themselves, namely, the lighting of country mansions. Already they have set on foot more than a score of such installations in various parts of the kingdom, and certainly the perfection of such a system as is now at work at Muncaster Castle should be sufficient encouragement to anyone possessing the means and the desire to give electric lighting a fair trial.

GENERATORS AND MOTORS.

Captain E. Dubois, writing under date of February 12th to the Editor of our contemporary *La Lumière Electrique*, made the following comments upon Mr. Mordey's recent paper:—

I beg to submit to your notice the following reflections which occurred to me upon reading the analysis of an article by Mr. W. Mordey on the subject of the dynamo considered as a generator and as a motor.

Mr. Mordey thinks rightly that in a motor the armature should have no polar action, its core having no other function than to act as a conductor of the lines of force, and that the whole action of the motor is due to the current of the armature cutting at right angles the lines of force of the field. This is the opinion of all good writers; and M. Marcel Deprez, in the remarkable articles that he has written on different occasions for *La Lumière Electrique*, has always maintained implicitly that the couple communicating with a ring traversed by a current situated in a magnetic field, resulted from the dynamic actions exercised on the single wire of the ring. He has, besides, given a demonstration of this fact in the number for October 31st, 1882, page 207.

In explanation of the fact that the coefficient of transformation in a dynamo is higher when acting as generator than when acting as receiver, Mr. Mordey remarks that the parasitic currents in the core of the induced part are of the same nature as the principal current in the first case, that they are of the opposite nature in the second, and that, consequently, in a generator these two kinds of currents, according to the laws of induction, act so as to become weaker, whereas, in a receiver, they tend to grow stronger.

Therefore, in this latter case, the loss of energy arising from the heating of the core must be greater.

I thought in a matter of such importance it would be well to make sure of the truth of this theory, and I therefore ascertained in the following manner the way in which parasitic currents act.

In a generator, when the speed is increased progressively, the current increases with it; consequently, it induces in the iron of the ring a current in opposition to the parasitic current which tends to diminish the increase of this current consequent on the acceleration of speed; when the speed arrives at a certain value, the parasitic current has a certain intensity, and it will easily be seen that it retains this intensity as long as the speed remains constant.

In fact, in this case, the contrary inductive action of the principal current ceasing, the intensity of the parasitic current would increase since the speed has been increasing; but if this current increased, it would induce an opposing current which would diminish the current of the ring, and consequently the speed of the ring would go on increasing; therefore, in order that this speed may remain constant, it is necessary that the parasitic current should keep the intensity that it had at the moment the speed became uniform. Thus, in a generator, the intensity of the parasitic current increases very slightly with the speed. This is not the case with a receiver. For with the increase in intensity of circulation, the speed increases; and, on the one hand, the current, increasing, gives rise to a current in the core of the induced part which is of the same nature as the parasitic currents, so that their intensity is increased; and this intensity is still further increased by the acceleration of speed.

Thus the intensity of these parasitic currents increases considerably with the speed.

The above reasoning will show that when the speed becomes constant, this intensity remains fixed at the same value as when the speed became uniform.

From the above remarks we may see how important it is to diminish the intensity of the parasitic currents, especially in the case of a receiver. This is effected, as we know, by dividing the iron of the induced part by several partitions of insulating material perpendicular to the axis of rotation and by carefully insulating these different subdivisions; thus the formation of parasitic currents in the entire mass of the induced part is avoided and the loss of energy due to the heating of the masses of iron is lessened.

When the mass of the induced part is not divided, the loss of energy $= \Sigma \text{E I}$, E being the electromotive force of one of these currents and I its intensity.

If we have n insulating partitions, the electromotive force of induction on the edge of one of these partitions will be $\frac{E}{n}$ and the intensity of the current resulting from it $\frac{I}{n^2}$, since the resistance of one subdivision is n times greater; and the loss of energy will then be $\Sigma \frac{E}{n} \times \frac{I}{n^2} = \frac{\Sigma \text{E I}}{n^3}$; *i.e.*, n^3 times less.

In one trial made with a receiver intended for the Creil experiments, M. Marcel Deprez found that the loss of energy corresponding to the parasitic currents amounted to 14 H.P. at a speed of 100 revolutions of the ring.

The mass of iron of the ring was well divided, but bolts insufficiently insulated connected the different circles forming the induced part and established amongst them a communication which diminished the

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resistance of the metal of the ring and increased considerably the intensity of the parasitic currents.

The rings having been taken off and the various parts of the divided core carefully insulated, the coefficient of transformation returned to a value admissible when compared with that attained in a generator.

This fact shows of what great importance it is to divide the mass of the induced part in a motor and to insulate carefully the different parts, so as to diminish as much as possible the loss of energy arising from their being heated. I thought that, the subject being a most important one, the above remarks might be of some interest.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

I.

IN building dynamos of the ordinary types, the first thing to do, writes Carl Hering in the *Electrical World*, is to calculate the diameter of the wire on the armature from the current to be delivered, then determine the number of turns, the diameter and length of the armature, as nearly as one can, from the electromotive force required; construct the frame by comparison with other finished machines, and determine upon the maximum speed allowable, which latter depends upon the diameter and weight of armature, length of shaft between bearings, rigidity of the frame, &c. Having done this, it is then necessary to determine the winding of the magnets, in order that, with this speed and armature, the machine may give its required electromotive force, or its constant potential, as in the case of compound machines. A description of a method of doing the latter without the factor of uncertainty, so often included, is the object of this article.

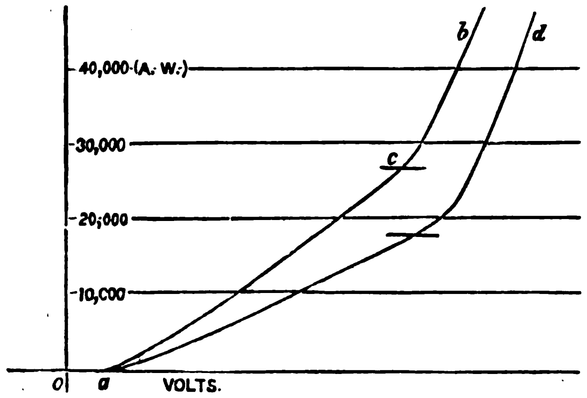

FIG. 1.—DIAGRAM OF MAGNETIC SATURATION.

It is evident that by winding the field-magnets similarly to another machine giving a different current or electromotive force, the former machine will give approximately the required electromotive force or current (depending upon the correctness of the calculation), and that the speed may then be varied until it gives the exact electromotive force. But it is a very uncertain method, for it is very difficult, in most cases, to make the proper change in the winding to correspond with the required change in the electromotive force, and, therefore, the chances are that the necessary speed obtained by experiment will either be too high to make the machine safe and durable, or that it will be too low to give it the required efficiency for the size and cost of the machine.

There is a sure and tolerably exact method, used by the writer, for determining the winding in order that the speed may not be too high or too low; that the brushes may be placed in the proper non-sparking position; that the magnet coils may have the proper resistance, so that they absorb the proper percentage of energy allotted to them, and in order that the cost of the wire on the magnets may not be too great; or that the total energy delivered by the machine may not be too small for its size and cost. By means of this method, the factor of uncertainty, or good (or bad) guessing, is entirely eliminated.

It is well known that the current of a machine depends on the size of the wire on the armature, so that if the armature is determined, that limits the current, at least within certain bounds. The only thing left to do, therefore, after the armature and frame are determined upon, is to make the machine give the proper electromotive force with this armature, while it is delivering the proper current, at the given speed.

As the electromotive force depends upon the speed, the number of windings on the armature, the size of the armature and the magnetism of the field-magnets, it is evident that if the armature and frame are completed and the speed decided upon, the only thing left to vary, in order to make it give the electromotive force, is the magnetism of the field-magnets.

In order to determine this, erect the machine with its proper armature, run it at its proper speed and wind some temporary coils to fit the magnets, being careful to note the exact number of turns of wire on these coils. Now run the machine at its proper speed, discharging the current from the armature directly into a large rheostat, lamps, a tub of acidulated water, or the like, and excite the field-magnets with the current from another machine or secondary battery. It is then only necessary to increase or diminish this exciting current, and to regulate the rheostat in which the current is absorbed until the current delivered by the armature is the proper amount and has the required potential, when the brushes are set to the proper non-sparking position. It is evident that this will enable one to properly adjust all the parts and conditions, and will allow of any slight changes of speed, or the like, which the running of the machine may show to be necessary. When it is running properly and has been "warmed up" sufficiently, measure the exciting current.

The intensity of a field is proportional to the ampère windings or ampère turns on the several magnets, that is, to the number of ampères flowing through the wire multiplied by the sum of the number of turns on all the magnets. It is immaterial whether the current be large and the number of turns small, as in a series machine, or *vice versâ*, as in the shunt machine, or whether it be a combination of both, as in a compound machine, if only the product of the current into the number of turns be the same.

The measurement made as above described will therefore, if the ampères of current be multiplied by the number of windings in the coils, give us the proper ampère windings required to make the machine give its required electromotive force when delivering the proper current. It remains only to calculate the proper size of the wire and the number of turns from this given quantity of ampère windings in order that the finished machine may have the required intensity of magnetic-field or the same ampère windings. This size of wire will, of course, depend on whether it is a shunt, series or compound machine, also on the allowable current or fall of potential in the magnet coils, on the cost of the wire, &c.

Before giving the formulæ in the three special cases, it may be well to call attention to some points which apply to them all.

The temporary coils may be wound on a shell of common tinned iron or the like, to fit the magnet cores. They must all have the same number of windings, and had better be connected in series, for if they are in parallel arc you are never sure, unless the resistances are exactly equal, that they all have the same current, and it is difficult to get both the resistance and number of turns exactly the same in all. They should be made about the same thickness as the finished magnets will probably be, in order to eliminate any difference in the mean distance from the wire to the iron. The size of the wire depends upon the machine or battery at the disposal of the constructor for

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the exciting current. If this gives a small current of high potential, use tolerably fine wire; if it gives low potential and large currents, use thick wire. In all cases it is best to make a rough preliminary calculation, so that one is not baffled by the incapacity of the exciting machine.

In the absence of an exciting machine, the coils may be supplied from the machine which is being tested, either by running a shunt current from it into the coils, in which case an adjustable resistance is placed in circuit with the magnet coils to regulate the shunt current; or they may be run in series with the external circuit, in which case an adjustable resistance must be placed as a shunt to the magnet coils, in order to regulate the current in them. In the first case, the armature must be credited with the current shunted off into the temporary coils, and in the second case the electromotive force of the machine must be measured at the poles of the armature and not at the poles of the machine, as there is a loss of potential in the magnets.

There is, naturally, a practical limit to the magnetisation which can be generated in the given cores and pole pieces, owing to the fact that the iron becomes saturated. This limit ought, in practice, not to be exceeded, for if it is, the magnetism becomes expensive as regards the energy consumed. There are some practical values given by different authorities regarding this limit. One of them is to take 110 ampère windings per square centimetre cross section of core, which is equal to 710 ampère windings per square inch. This is probably for round wrought iron cores. The writer found for a certain machine with cast iron oval magnets, 37 ampère windings per square centimetre, or 240 per square inch, to be about the safe and economical maximum. Of course, more than this could be taken, but it is not to be advised, for the magnetism then no longer increases in proportion to the ampère windings. On the other hand, to use much less than this, makes the machine uselessly heavy and large.

As the magnetisation varies less with a varying magnetising current after the point of saturation is reached, some makers prefer to use their machines over saturated, because then the current delivered by them is more constant for slight variations in the magnetising current. In other words, the machine is less apt to change its electromotive force for slight changes in the external resistance. When this is done it is at the expense of the energy consumed by the magnets, and the point of saturation should therefore not be exceeded any more than is necessary to obtain this steadiness.

The size of the core being given, the limit of the ampère windings can easily be determined from the above constant, and it should not be exceeded, at least not much, unless the iron is particularly good. As the economic density of the magnetism, or the saturation limit, depends so much on the iron used, it is better, in all cases where the constructor has the opportunity, to find the proper limit himself by the following method:—

With the machine just as it is for the foregoing test, run it at a very low speed, for instance, belting from the shaft directly; run it on open circuit with a fixed position of the brushes at about the theoretical neutral line. Connect the brushes with a voltmeter, and excite the magnets as before with the current from another machine, beginning with a small current and increasing as high as the wire will stand, measuring in each case the exciting current and the electromotive force at the poles.

The electromotive force on open circuit is a direct representative of the magnetisation of the field, that is, the useful magnetism. The ampère windings, that is, the exciting current multiplied by the number of windings in the coil, represent the cost of the energy to produce this magnetism. By plotting these values a curve is obtained which represents the relation between them, and which will show up to what degree the one rises proportionally to the other. In the accompanying diagram (fig. 1) such a curve has been plotted, the values being taken from an actual case.

The ordinates represent the ampère windings, and the abscissæ the potential. We see from the curve, *a*, *b*, that the useful magnetism, or its representative, the potential, rises proportionally with the ampère windings up to about 27,000 ampère windings, at the point, *c*, where it takes a decidedly different direction. This point is the limit at which the useful magnetism is economically obtained, and is, therefore, the limit to which the machine should be magnetised. It is the point at which the magnets are saturated. Dividing this quantity of magnetism, or this number of ampère turns, by the area of cross section of all the magnet cores, gives the constant above referred to, that is, the maximum allowable density of the magnetism just before saturation. In this special case there were four magnets, each with a cross section of 181 square centimetres, giving, therefore, 37 ampère windings per square centimetre, or 240 per square inch.

The distance, *o*, *a*, shows the remnant magnetism, while that part of the curve, *c*, *b*, shows the increase of magnetism due to the coil itself, after the iron is saturated.

This diagram also shows a very important point to be noticed in building compound machines, to be referred to later.

The speed at which the machine must be run for this test depends, of course, on the range of the voltmeter at our disposal. It should be so chosen that the values for the potential are inside of the range of the instrument, which can be determined by trial. Shunting the instrument with a high resistance, or putting a resistance in series with it, are devices which may be used to reduce the values to the range of the instrument; provided there is no appreciable current allowed to flow, as that would, by shifting the diameter of commutation, change the results.

THE ELECTRIC ILLUMINATION OF LIGHTHOUSES.

LIEUT. JOHN MILLIS, U.S.A., in the report of the Lighthouse Board for 1885, has given a report on observations on the subject of coast lighting by electricity.

The Lieutenant's report commences with a description of the plant at Hell Gate and review of the work done up to date. He says:—"Nine Brush lamps are placed at the top of the tower, and access to them is obtained by means of a counterpoise elevator. The maximum candle-power of each of these lamps by actual measurement is 3,114 standard candles. Two dynamo-electric machines of the Brush pattern form the means of generating the current used, giving about 343 volts at the terminals and 33 ampères. The light has been several times extinguished owing to the inexperience of the keepers, and several such accidents as are to be expected in a new plant, but there have been no interruptions since March 24th, and Lieutenant Millis states that with the greater experience of the keepers, and the electric apparatus being duplicated, there is now little danger of another extinction except from failure of the engine or further trouble with the ice." On one occasion ice formed on the elevator ropes and prevented access to the lamps.

The arc light possesses the qualifications of intensity to an unsurpassed degree, and while experience has shown that its penetrating power is less proportionally than that of a light in which the longer wave lengths predominate, the electric arc is believed to furnish the means of creating a light which for all states of weather will be visible farther than any that can be otherwise produced. The light-giving surfaces in the electric arc are extremely small compared with the intensity, but as the quality of fixedness is to a great extent wanting, the smallness of the luminous surfaces becomes a serious defect rather than an advantage. Much larger optical apparatus is required than would be necessary were the light fixed in position, in order to

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diminish the effect of small movements which constantly occur, and frequent adjustment of the light is required. With regard to the light, a notable difference exists between that class of arc lamps operated by continuous current and that requiring an alternating current.

The Lieutenant states that, in lamps of the former class, the most advantageous position is with the carbons vertical, but even in this position the direction of the maximum illumination is 45° from the horizontal. For this reason, and on account of the greater difficulty of keeping the light adjusted to the focus of the lens, continuous current arc lamps in any of the forms heretofore devised are not suited for lighthouse purposes, and their use may be said to be practically abandoned. The De Meritens alternating current lamp, with a lens specially adapted to it, and the De Meritens alternating current magneto-electric machine constitute what may be called the most practicable, and, in fact, the only arc electric lighting apparatus at present in use for lighthouses.

As certain qualities possessed by the incandescent electric lamp promised to render it of use as a lighthouse illuminant, considerable experimental work in this direction has been done.

Incandescent lamps of much higher candle-power have been made, and a lamp for use in a first order lens has been completed, the preliminary tests showing that it can be operated continuously and with safety at about 450 candle-power. Experiments have shown that the readiness with which this form of lamp can be extinguished and relighted promises to render it applicable for intermittent lights with the great advantage of simplifying the optical apparatus and doing away with the revolving machinery. It is a matter of regret, the Lieutenant continues, that it has not been practicable to thoroughly study the relative penetrating power of lights of different qualities by actual observation from a distance, since this constitutes one of the most important features of the whole subject. Such observations as it has been practicable to make indicate, however, that the incandescent light is not inferior in penetrating power to flames, and is without doubt relatively superior to the electric arc, and is, therefore, better adapted than the arc lamps for red lights since the proposition of light of short wave lengths is not so great. The simplicity of the lamp and fixtures required, the ease with which it can be accurately adjusted in position and kept so, the fact that the lamp itself requires no attention while in operation, and the readiness with which it can be applied to any first order lens now in use, with no disturbance of the present illuminating apparatus except the temporary removal of the burner, are some of the further advantages possessed by this lamp which seem to warrant continued and more thorough investigation. The electric lamp curve shows that a large percentage of the light falls upon the refracting drum of the lens which is by far its most efficient part. The amount of radiation that takes place at a greater angle than 45° from the focal plane is so small, that beyond these limits the catadioptric rings of the lens might be omitted entirely. The electric lamp is greatly superior to the oil flame in another respect. The greater size of the flame produces more useless divergence of the light after it leaves the lens, and the form of the flame is variable. Its height is considerably affected by the state of the weather, and unfortunately the lamp always burns poorest in thick weather, when most needed. Besides the diminished luminous intensity which results, the brightest part of the flame is lowered, and if the burner be so placed as to give the best effect when the lamp burns properly during bad weather, the light is not only less bright, but is thrown too high above the horizon. Of electric generators there are now obtainable many varieties, which are well constructed, easy to operate, efficient, and suited to any condition which may occur in practice. Steam motors especially designed for this work have also been carried to a high state of perfection, and the only unsolved part of the problem of the electric illumination of lighthouses, or more properly the part less perfectly solved than any other is that which relates to the lamp itself, and it is, therefore, to this that experiments and study have been principally directed.

DYNAMO TESTING.

THE accompanying illustration represents the two Edison-Hopkinson machines recently tested at the works of Messrs. Mather & Platt by a new method introduced by Dr. John Hopkinson, F.R.S., and which was described in our last issue.

The system is applicable only in special cases which are not likely to arise in practice. The machines were electrically connected as shown in the diagram, where G is the armature of the generator, M that of the motor, F the field magnets of the generator, and F_1 those of the motor, both fields being supplied with current from the brushes of the generator.

It will be seen that if the exciting current were alike in both cases, the counter electromotive force created in M would be equal to the electromotive force created in G, and no current would pass from one armature to the other. To allow a current to flow it is necessary to slightly lower the counter electromotive force of M, and this is done by reducing the exciting current in F_1. In order to regulate the exciting power of the motor field magnets, a rheostat, r, is inserted into the circuit. The main current is measured by observing, on a potentiometer, P, placed in a distant room, the difference of potential existing between the terminals of a platinoid resistance, R. This resistance is so low—·0058 ohms—that the strongest current which is used during the range of experiments does not sensibly heat it.

Mr. Gisbert Kapp, the well-known electrical engineer, who was amongst those assembled to witness the experiments made in Manchester, had afterwards an opportunity of repeating the tests, and he gives the results of his experience to the *Engineer* in the following words :—

The experiments were carried out thus :—The two dynamos were first run with the brushes off, neither of the two fields being excited. This gave the power necessary to overcome the friction in the bearings, the resistance of air and that used up in the dynamometer itself. The next experiment was to excite the two fields separately, and run the dynamos still with the brushes off. This gave the power required to overcome the resistances just specified, plus the energy absorbed by revolving the two armatures in magnetic fields, or, as it might be termed, the power absorbed by magnetic friction. Roughly speaking, the magnetic friction was found to increase the power required for running empty by 50 per cent. The field coils were then coupled up as shown in the diagram, and the proper power tests were made. In the following table are given some of the results obtained :—

Dynamometric Experiments on two similar Edison-Hopkinson Dynamos.

Scale divisions on spring balance...	21·6	30	60	48·5	44
Revolutions per minute	808	802	764	808	808
Electromotive force at brushes of generator	—	—	110·12	118·87	124·41
Electromotive force at brushes of motor	—	—	107·34	116·86	122·97
Electromotive force in armature of generator	—	—	113·79	121·56	126·40
Counter electromotive force in armature of motor	—	—	103·78	114·29	121·12
Main current in ampères	—	—	358	258	186
Shunt current in field of generator	—	6·9	6·72	7·21	7·57
Shunt current in field of motor ...	—	6·7	5·23	5·92	6·53
Current in armature of generator...	—	—	370	271	200
Current in armature of motor ...	—	—	358	258	186
Horse-power registered on dynamometer	5·18	7·17	13·66	11·70	10·60
Horse-power converted in armature of generator	—	—	56·20	44·00	34·00
Horse-power converted in armature of motor	—	—	49·80	39·60	30·20

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The horse-power converted in the armature of the generator is that actually appearing in the form of internal electrical energy. The power which has to be supplied to the spindle is somewhat greater than the horse-power converted, and the problem is to find how much greater; in other words, we want to find the efficiency of conversion. Similarly the horse-power converted in the armature of the motor is the electrical energy disappearing in the process of conversion into mechanical energy, which flows through the coupling back into the spindle of the generator. This power is somewhat smaller than that given in the table, because a certain loss occurs during conversion, and we want to find how great this loss is. Since the two machines are similar in size, we shall not commit any great error if we assume that the unknown loss in conversion is the same in both armatures. Let x represent the horse-power thus lost. Then we have the following relation in reference to the experiment given in the third column:—

Power supplied from the external source ...	13·66
Power supplied by the motor	49·80 − x

The sum of these two must be equal to 56·20 + x, which represents the power actually supplied to the spindle of the generator. We have therefore the equation—

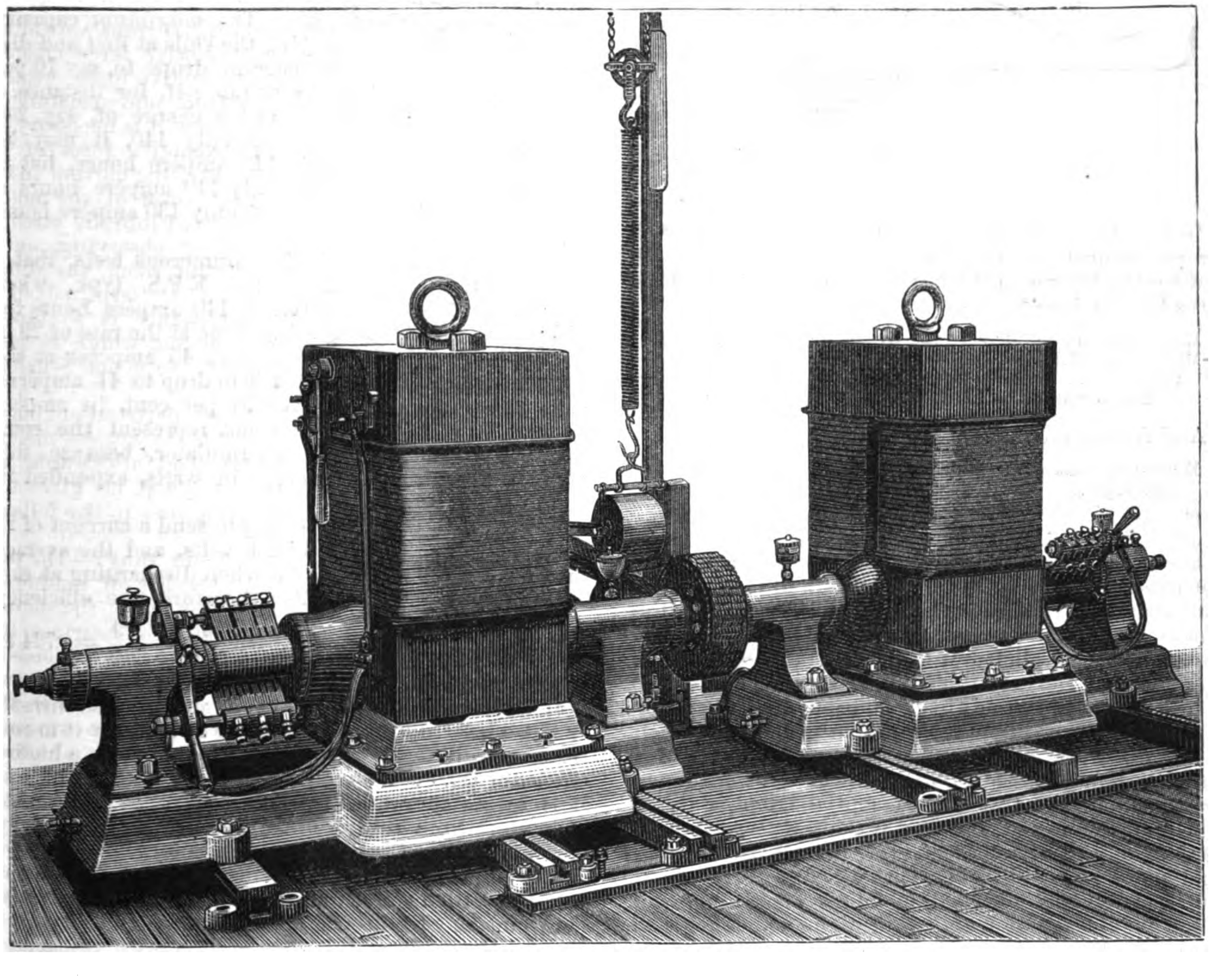
$$13·66 + 49·80 - x = 56·20 + x,$$

whence $$2\,x = 13·66 + 49·80 - 56·20$$

$$x = 3·63$$

It should here be remarked that in taking 13·66 as the power actually supplied to the whole combination we have made no allowance for the loss occurring in the dynamometer itself. Now from the first column it appears that 5·18 horse-power are required to overcome the purely mechanical resistance of the dynamometer, the friction of armature spindles in their bearings and the air resistance of the armatures. The latter two must properly be charged to the dynamos when determining their commercial efficiency, whereas the former should be deducted. It is extremely difficult to separate these losses, and we shall have either to neglect the loss in the dynamometer altogether, which would make the dynamos appear less efficient than they really are, or we must deduct the losses due to the dynamometer and the mechanical friction of the armatures together, which would make the dynamos appear more efficient than they really are. In the latter case the power applied externally would be $13·66 - 5·18 \frac{764}{808} = 8·76$, and the unknown quantity $x = 1·18$.

This value agrees fairly well with the tests in the first and second column where the increase of power due to the magnetisation of the iron core of the armature had been directly ascertained. But there is one point which has not been taken into account, and which would slightly modify the efficiency when either of the dynamos were used in actual practical work. This is the increase of mechanical friction in the bearings due to the strain of the belt. It is a very different thing to transmit 10 horse-power through a belt embracing three-fourths of the pulley, and to transmit 60 horse-power through a belt embracing, say, only four-tenths of the pulley. The strain in the driving end of the belt will, in the latter case, be probably ten times greater, and therefore the pressure of the spindle against its bearing, and the power absorbed by friction, will also be considerably increased. In order to make an allowance on this head, probably the fairest thing to do is to take the mean between the two values for x, and in this case we have :—



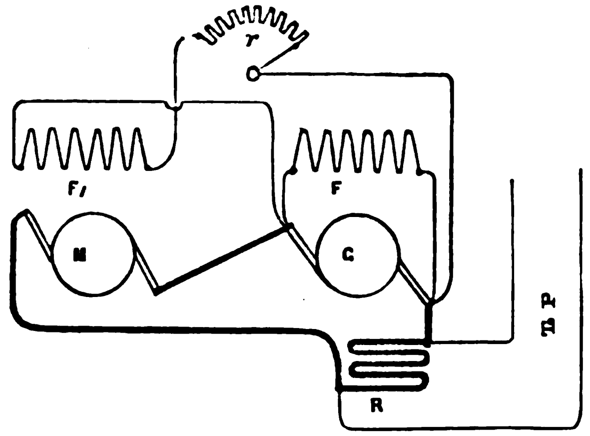
Horse-power in the belt driving the dynamo ...	58·60
Horse-power delivered electrically at the terminals	53·60

Commercial efficiency, 91·5 per cent.

Similarly we have for the motor :—

Horse-power delivered electrically to the terminals	53·60
Horse-power obtainable at the belt	47·40
Commercial efficiency, 88·5 per cent.	

In this case the commercial efficiency is somewhat lower for the motor, which is probably due to the fact that the field-magnets were not fully excited.



In the same manner we find the average value of x for the figures in the fourth column to be 2·36, and that for the figures in the last column to be 2·10. This gives for the dynamo :—

Horse-power in belt driving the dynamo	46·36 and 36·10
Horse-power delivered electrically at the terminals	42·00 „ 30·40
Commercial efficiency	90·6% „ 84%

And for the motor :—

Horse-power delivered electrically to the terminals	42·00 and 30·40
Horse-power obtainable at the belt ...	37·24 „ 28·10
Commercial efficiency	88·7% „ 92%

The method here adopted by the writer in analysing the experimental results is somewhat different from that adopted by Messrs. Mather and Platt, but the results arrived at by either method agree fairly well. The commercial efficiency, determined according to the makers' way of reckoning, is 93·23 per cent. for the tests recorded in the third column, and the discrepancy of 1·7 per cent. is due to the fact that in the calculation which gives the higher efficiency, no allowance was made for the increase of friction in the bearings due to the greater pull of the belt where the latter is transmitting the full power, instead of only that portion of the power which is wanted. These results are very instructive. In the first place, they prove that an actual commercial efficiency of 90 per cent. and more can be obtained with a high-class dynamo. They also show that the dynamo, when designed on sound scientific principles, is equally efficient, whether used as generator or motor, a point which has been much discussed of late in the columns of the scientific press. A very important result of the experiments is also that it has been proved to be possible to electrically transmit energy over short distances with a total loss not exceed-20 per cent.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XII.

GENERALLY speaking, the storage capacity of a secondary battery depends upon the weight of its active material, provided that this material is distributed in a rational manner, and that the electrolyte is of a volume and strength most suitable for the free decomposition of water and the economical distribution of the gases. Thin plates of large superficial area facilitate rapid action, that is to say, they permit of a higher *rate* of charge or discharge than thick plates of equal weight or volume. The plates of the tramcar cell which we have investigated are, on an average, ⅛ of an inch in thickness, and they offer a total surface of about 11·5 square feet to the liquid. Under ordinary circumstances these cells are charged at the rate of 30 ampères, and discharged at the rate of about 45 ampères; but frequently they are required for short periods to yield a current rate of 100 and even 150 ampères.

The usual way to test the capacity of a secondary battery is to charge the same at as uniform a rate as possible, taking readings on the ammeter and the voltmeter, say, every half-hour, or even every quarter of an hour, then multiply the ampères by the hours; afterwards discharge the battery through a constant resistance, and note the current and E.M.F. at frequent and equal intervals of time. The *maximum* capacity can be found by overcharging the cells at first and discharging them until the current drops to, say 10 per cent. below the initial current rate ; if, for instance, a well "formed" battery received a charge of, say, 200 ampère hours, and it returns only 140, it may be assumed that its capacity is 140 ampère hours, but if the same is recharged with only 140 ampère hours it will be found that a return of only 130 ampère hours may be got out.

The author has found, after numerous tests, that a 23-plate tramcar cell, of the E.P.S. type, when thoroughly formed, will return 140 ampère hours for 153 put in, the charging being done at the rate of 29 to 30 ampères, and discharging with 46 ampères at the commencement and allowing it to drop to 41 ampères, showing an efficiency of over 91 per cent. in ampère hours. This, however, does not represent the commercial efficiency of the accumulator, because this depends upon the total energy, in watts, expended in charging the cells.

The average E.M.F. necessary to send a current of 29 ampères through a cell is 2·4 volts, and the average pressure that can be obtained when discharging at, say, 46 ampères, is only 1·9 volts ; therefore, the efficiency of a tramcar cell cannot exceed $\frac{140 \times 1·9}{153 \times ·2·4} = ·724$ or 72·4 per cent.

If we discharge the battery at a lower rate of current, or if we interrupt the discharge so as to allow it to rest for a few minutes between each reading, then a higher efficiency than that stated above can be obtained, and it is by no means difficult to obtain, at reasonable current rates, a return of 80 per cent of the energy expended in charging a secondary battery.

The annexed table is an average one out of a number obtained with a set of tramcar cells. The variations in the charging currents are due to the irregular dynamo speed. Discharging through an iron wire resistance, the current at first dropped very rapidly as the wire became hot, but afterwards the current rate dropped very slowly.

CHARGE.		DISCHARGE.	
Time.	Amperes.	Time.	Amperes.
6.30	29·96	9.15	55·64
7.0	29·96	9.30	47·08
7.30	29·96	9.45	46·65
8.0	29·96	10.0	46·65
8.30	29·96	10.15	45·0
9.0	29·96	10.30	45·0
9.30	29·96	10.45	45·0
10.0	28·89	11.0	45·0
10.30	29·96	11.15	45·0
11.0	27·82	11.30	44·37
11.30	27·82	11.45	43·87
12.0	27·82	12.0	43·44
		12.15	41·9

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With 140 amp. hours' useful capacity, and 114 volts, out of 60 cells in series, we obtain thus 15,900 watt hours, or 21·6 H.P. hours, which at the rate of 46 ampères, including the energy wasted through frequent stopping and starting the car, will give sufficient power to propel the vehicle for over three hours on the line which served as a basis for all our calculations. From the efficiencies obtained with the battery and allowing a loss of 20 per cent. between the engine and the dynamo which charges the accumulator, we find that a steam engine of 120 H.P. will be necessary for the maintenance of the traffic of twelve tramcars. We assume here that no artificial resistances are employed in starting the vehicles or regulating their speeds and powers: for, supposing that there are two motors, giving 1·9 ohms' resistance when joined in series at starting, then the maximum current under these circumstances will only be $\frac{114}{1 \cdot 9} = 60$ ampères; whereas the current on the level road will be 32 ampères. On the other hand, there will be a great strain upon the accumulators when the car is running up inclines, and the motors are (in order to exert their maximum power) joined in parallel; then the current to be supplied by the cells may be 90 or 100 ampères, and the E.M.F. of the same will drop considerably below 1·9 volts per cell, thereby impairing the efficiency of the whole system for the time. Therefore we must provide for these abnormal conditions and raise the H.P. of our charging machinery by at least 22 per cent., bringing it up to 146 H.P.

THE WEST COAST OF AFRICA SUBMARINE CABLE.

THE adjourned debate on the Post Office Submarine Telegraph Contract (St. Vincent to the West Coast of Africa) was resumed on Friday, the 5th inst.

On the question being put "That the contract dated the 19th day of January, 1886, for the construction of a submarine telegraph line from the Island of St. Vincent to the West Coast of Africa be approved,"

Mr. HENNIKER HEATON said he rose to oppose the motion and to move as an amendment "that the whole question be referred to a Select Committee of the House." The cable which under this contract the Government agreed to subsidise for the purpose of its construction was already constructed when the contract was entered into on the 18th of January, 1886. The cable was constructed by the India Rubber and Gutta Percha Company, and it seemed to him that the Treasury minute on this subject was entirely misleading. The person at the bottom of this matter was a gentleman who was greatly mistrusted by those who had any knowledge of these matters—he meant Mr. John Pender, a gentleman who was always looked upon with suspicion; and in asking for a Select Committee to examine into all matters connected with this contract he thought he was making a very reasonable request of the Government. The contract which the House was now asked to sanction bound the British Government to pay £380,000 to John Pender and Company for the construction of a telegraph cable from St. Vincent to the West Coast of Africa. John Pender and Company had already a line of cable on the East Coast of Africa, for which the Government paid a subsidy of £25,000 a year. By now obtaining the contract for the West Coast of Africa, John Pender and Company would obtain a practical monopoly, and he was sure that the House would not submit to a contract of this nature being entered into without the most searching inquiry. He believed that the time had come for the Government of this country to own these cables that connected England with our great colonies, and the effect of this contract was to throw the monopoly of the cable to Australia into the hands of John Pender and Company. While these large subsidies were being paid to one company there was no hope of inducing the Government to construct cables themselves. He had already given notice of motion to the effect that the Government should construct an alternative line of cable round the West Coast of Africa to the Cape of Good Hope, but if this contract were approved his proposal could not be adopted. As announced in the *Times* of the 13th of October, the Gutta Percha Company agreed to construct the cable from St. Vincent to the West Coast of Africa and thence to the coast of Australia without subsidy. Without warning John Pender and Company came in, and, after the cable had been laid down, purchased the rights of the company, and now endeavoured to obtain a large sum of money from the Government as a subsidy for the construction of the cable, although, as a matter of fact, it was already laid down and almost in operation. He could prove that the Treasury minute on this matter was erroneous, and he had other information in his possession which was more suitable for a Select Committee. He was desirous of avoiding saying anything offensive, and he should not state the source of his information except to the Select Committee, but he could readily prove that this contract was of a character which, to use a very mild term, deserved inquiry. If the Government granted an inquiry, as he maintained they were bound to do, they would be enabled to examine various papers, to call witnesses, and obtain other evidence which would enable them to understand the transaction which had taken place, and that evidence would show that the transaction was not an honest one. He did not say one word against the members of the late Government, but this contract was entered into just before they left office, during a time of election excitement, when they were influenced by information put before them of an erroneous character. In consequence of the monopoly granted to John Pender and Company a rival company found that the concession granted to them was of no avail, and that they were entirely in their power. At a time when they were suffering great depression in England he thought that to throw away £19,000 a year, or £380,000, for the construction of a cable on the West Coast of Africa should be condemned. If an inquiry were granted he would pledge himself to produce evidence to show that the contract was not an honest one. He begged to move that the matter be referred to a Select Committee of the House.

Sir H. HOLLAND said that of course he did not know what line the Financial Secretary to the Treasury would take with regard to this subject, but if he might tender his advice it would be not to allow this contract to be referred to a Select Committee. He was somewhat surprised at the insinuations which had been thrown out by the hon. member, who had stated that these transactions, which had been entered into both by the late and present Governments, were not honest. The hon. member further said that the decision of the late Government was arrived at during a period of election excitement. On the contrary, he could tell him that one of the first matters which came before him in July prior to the period of election excitement was the question of this telegraph. It was decided by the late Government that it was absolutely necessary to lay down this telegraph line to the West Coast of Africa. That was an opinion which had been arrived at by the Secretary of State for War, the Admiralty, and the Colonial Office, and he ventured to think that it was hardly possible for the Treasury to refuse to consider the question of this contract. The hon. member had averred that when this question came before them a company had started to lay down a cable. It was true that the India Rubber Company had agreed to lay down a line from St. Vincent, but the line was a quasi-foreign one with which they could make no terms. The hon. member said that the company had now established a monopoly and could charge what rate they pleased, but if he looked at the contract he would see that the rates were laid down and fixed by it. Both the companies tendered, and they both required a subsidy. He denied that they had laid the line in July last. The late Secretary of State for War and the late Colonial Secretary and he himself went again and again over the question of the amount of the tenders and the amount of the subsidy; and the result was that it was reduced to £19,000, which was lower than the subsidy required by the India Rubber Company. The Treasury had no option but to take the best terms they could obtain from the company that would lay down the line to the West Coast of Africa. The Government had to say which company offered the best terms, and after all the attention and examination which had been given to the matter it would be idle to refer it now to a Select Committee. He therefore hoped that the Secretary to the Treasury would adhere to that contract.

Mr. H. FOWLER said that the charge of the hon. member for Canterbury was that they were entering into a contract that was not an honest one. Now, that question had been before three different Governments for a succession of years, and it had been most carefully considered. The matter involved two points—namely, a question of policy and a question of internal administration. On the first question he frankly conceded that the House had both the right and the duty to express its own opinion. That question was whether it was for the political and the commercial interests of this country that a telegraph cable should be laid to the West Coast of Africa. If the House referred to the Treasury minute of February they would find that the Treasury were of opinion that that scheme would be of advantage both to the West African colonies and to this country, commercially and politically. The question was raised in the first instance under the former Administration of the present Prime Minister, and it was considered by the Cabinet of that day that it was for the interests of this country that there should be telegraphic communication with our settlements in West Africa. Anybody who was aware of the grave public inconvenience that had been suffered from the want of that means of communication would be of opinion that that Cabinet decided rightly. That decision was confirmed by the Cabinet of Lord Salisbury, and again by the present Government. Of course the House might, if it chose, overrule the judgment of three successive Governments and of those who, being responsible for the military, naval, colonial, and commercial interests of this country, were all of opinion that it was necessary to have that telegraphic communication. The Treasury, in its permanent officers, possessed a staff of the highest capacity and experience, which was totally incapable of a dishonest transaction. Their fault, if it was a fault, was their desire to safeguard the public interests and to avoid, if they could, all undue expenditure; and it was not likely that the House could enter into a contract on better terms than the permanent officials of the Treasury could

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do. The Treasury invited tenders, and they received three, one of £23,000, another of £29,000, and another as high as £102,000. They decided to accept the one for £23,000. There was a difficulty in the way, arising in connection with the Island of St. Vincent not being British territory; but that difficulty having been got over, the company was in a position to complete the contract. Negociations were opened, and he must express his admiration of the manner in which the late Chancellor of the Exchequer was enabled to reduce the subsidy to £19,000, of which the colonies themselves would contribute £5,000. The English Government were only to pay half-rates; they were to have priority for their messages and to have the right to nominate a director to protect their interests; while in time of war they were to take possession of the telegraph. The House was asked to withhold its confidence from the Treasury and to refer the contract to a Select Committee. That was not the mode in which the public business either had been or ought to be conducted. The hon. member for Canterbury, before he concluded, had rather unveiled what was behind. The hon. member said he was very anxious that there should be another cable laid to Australia, and that the Government should own all those submarine cables. They knew what that meant. They knew that the Government paid between £10,000,000 and £11,000,000 sterling for the purchase of the telegraphs, which, he supposed, were not worth above half that sum. And now probably some people would like the Government to buy up the submarine telegraphs also. He, however, hoped that the Government would do nothing of the kind. The policy now being pursued of paying the company for the work they did was the wisest and the best that the Government could adopt. He objected to the appointment of a Select Committee, which, in fact, was a declaration on the part of the House that the Treasury was not competent to do its work. He submitted the whole matter to the house as a question of public policy which had been decided unanimously by three successive Governments without any element of party conflict entering into the consideration of the subject.

Mr. LABOUCHERE congratulated his hon. friend on having adopted the true and proper method pursued by Secretaries to the Treasury in answering inconvenient proposals. No one supposed that the Treasury officials were anything but honourable men, but when a contract was made and submitted to the House surely the House had a right to consider whether it was wise, expedient, or desirable. The Secretary to the Treasury had himself explained how sharply the House ought to look after the Treasury and other Government officials. Reference had been made to the large sum of money which had been paid for taking over the telegraph system of this country. Why was this? Such a large amount of expenditure was due to the fact that the House left this matter to be settled by the Treasury and other officials; and it seemed to him that the hon. gentleman proved that the House could not trust Government officials in matters of this kind, but that they ought to carefully overhaul every contract brought before them. The hon. member who brought this subject forward did not complain that the contract was dishonest on the part of the Treasury, but that the contract was dishonest on the part of those with whom the Treasury dealt. The Secretary to the Treasury said there were two points to look at—one a question of policy, whether it was to the political and commercial interest of this country to have telegraphic communication with our African colonies. He admitted that it was desirable to get this communication as cheaply as possible. What were the allegations made by the hon. member? It was proved that three years ago the Treasury and the postal authorities thought that it was desirable that a cable should be laid between the island of St. Vincent and the West Coast of Africa. Tenders were submitted to the Treasury by various companies. The lowest tender was that of the Eastern Telegraph Company, and the contract was signed on the 19th of January to construct and lay a cable from the island of St. Vincent to the West Coast of Africa for the sum of £19,000 per annum during 20 years. Was this cable then constructed and already laid by another company? The hon. gentleman said no. Would the hon. gentleman accept the news in the columns of the *Times* as a fair statement of the facts? In the *Times* of the 13th of October there was an account of a ship being sent out with a cable by the India Rubber Cable Company to lay this cable. There was a dinner and the usual festivities afterwards. In the *Times* of the 21st of November there was a statement that the cable had been laid. Consequently the allegation was this, and it was a clear one, that the India Rubber Company did lay a cable from the island of St. Vincent to the West Coast of Africa, and the reason was that they were obliged to lay it because they had land lines and small coast lines connecting Bathurst with the Cape of Good Hope. They were really obliged to lay the cable in order to fructify their land lines. When the contract was signed, therefore, with the Eastern Telegraph Company to construct and lay a cable for £19,000 a year, he asserted that, unless those two statements in the *Times* should be contradicted, a cable had been constructed and laid by the India Rubber Company. The India Rubber Company had the exclusive concession of laying cables to the island of St. Vincent. The Eastern Company, when they put in a contract below that of the India Rubber Company, knew very well that they could not carry out the contract; but when the India Rubber Company found that they could not obtain a contract the Eastern Company came and said, "Sell us your cable, then we will get a contract to construct and lay a cable from those two points, and we will obtain £19,000 per annum." The point which he wished to urge on the attention of the House was that a cable had been laid without any contract with the Government and without any subsidy from the Treasury. This statement was in the *Times*, and he could not see the object which the Government had in entering into a contract with the Eastern Company when the work had been done by another company without a contract two months before. The whole system of subsidies was, in his opinion, radically bad. We already paid to the Eastern Company £35,000 for telegraphic communication on the eastern coast of Africa. Now we were called upon to pay another large sum because this company had suddenly bought a cable laid by and belonging to another company. In these circumstances he thought the hon. member was justified in denouncing this contract.

Mr. BADEN-POWELL said the hon. member was quite in error in stating that this contract closely affected Australia.

Mr. LABOUCHERE said this was a link in one of the telegraphic routes with Australia.

Mr. BADEN-POWELL said this cable did not connect Australia with this country, and it was not likely that it ever would.

Mr. HENNIKER-HEATON said it was one of the projected lines.

Mr. BADEN-POWELL thought the contract was one that the House ought to support, as it would be of immense benefit in securing an alternative telegraphic route with our African colonies. He hoped, however, that the Government would take precautions against the evils that might arise in the way of excessive rates if both those routes were in the future to fall into the hands of the same company.

Sir M. HICKS-BEACH said he took immense trouble with this contract, and he believed that in the tender as cut down to £19,000 the country had an exceedingly good bargain. This cable would save many thousands a year by securing telegraphic communication between this country and our colonies in Africa, and thus tending to guard us from native wars. The commercial advantages would also be very great.

Mr. MOLLOY asked whether it was not a fact that the India Rubber Company, a solvent company, were prepared to lay the cable at their own expense, and that some person stepped in, purchased the contract, and then came to the House for a large subsidy. Unless a more satisfactory explanation than had been as yet given was furnished he should oppose the vote.

Mr. MUNDELLA begged to state, by permission of the House, what had been already stated half-a-dozen times, that the India Rubber Company asked for £29,000 a year, that they only laid a small section of the cable, and when they got the contract for the whole distance they handed it over to another company who did it for £19,000.

Mr. ILLINGWORTH complained that the wealthy South African colonies were asked to pay only £5,000. It was the large owners of land in those colonies that were chiefly interested, and it was to make them a great aristocracy that the late wars were waged.

Sir F. STANLEY said that the hon. gentleman was quite mistaken. This contract related not to South Africa, but to the West African settlements. The fervid imagination of the hon. gentleman had run riot with regard to large landholders. He did not know that the proprietors in the West African colonies possessed even "the three acres and a cow." The hon. gentleman thought £5,000 was very little to pay, but the fact was that the matter had been very carefully looked into, and the proportion of £5,000 was allotted on a fair basis. He believed this contract would be the means of securing the prosperity of a large portion of Africa.

In answer to Mr. Brunner,

Mr. H. FOWLER said that the India Rubber Company asked between £20,000 and £30,000. The company proceeded to lay a small portion of the cable—about one-sixth of the whole—and ultimately when they got the complete contract they sold the cable they had laid, with their rights, to a company with whom his right hon. friend opposite arranged better terms.

The House divided, and the numbers were—

For the amendment	34
Against	199
Majority	—165

The motion was then agreed to.

Lighting of the Liverpool Exhibition.—The electric lighting of the Liverpool International Exhibition, which is now approaching completion, has been entrusted to the Liverpool Electric Supply Company, Limited, Messrs. Holmes and Vaudrey being the engineers. More than 300 arc lamps will be distributed through the buildings (which cover eight acres), and several thousand incandescent lamps. The dynamos will be supplied by the Anglo-American Brush Company. The motive power will consist of six semi-fixed compound engines with boilers attached, two pairs of 40 H.P. compound engines, and four separate fixed engines, the latter supplied with steam from three large boilers of the locomotive type. All the engines and boilers will be supplied by Messrs. Marshall, Sons and Co., of Gainsborough. The Liverpool Electric Supply Company will also exhibit, in conjunction with Messrs. Crossley Bros., of Manchester, several sets of electric light plant driven by gas engines.

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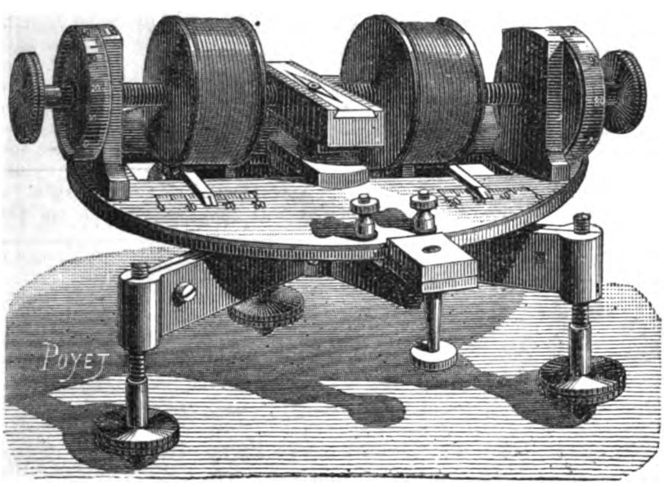

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Clerk to the Board.

Public Offices,
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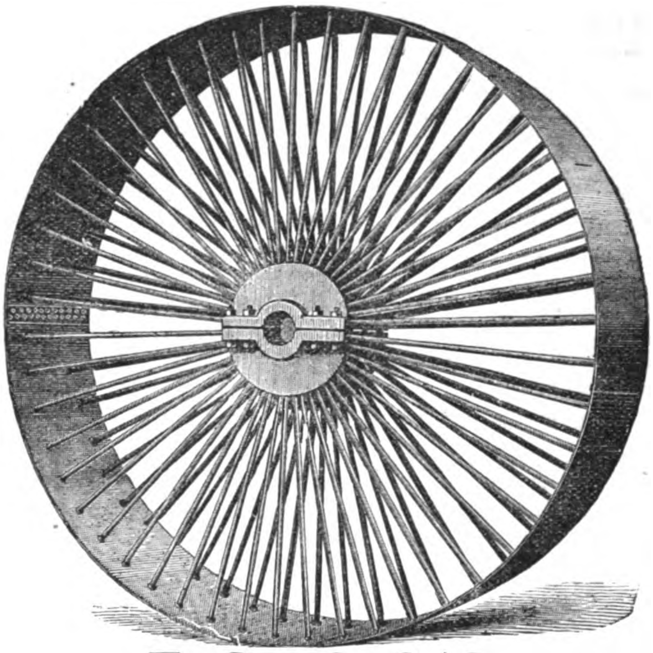

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NOTES.

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Lighting at the Indian and Colonial Exhibition.—The Quadrant dining rooms, refreshment rooms, and some other parts of the Indian and Colonial Exhibition are to be supplied from storage batteries, manufactured by the Electrical Power Storage Company, Limited. The batteries will give current for a total of about 1,000 lamps. As this is the largest public exhibition of storage batteries which has yet been made in London the working of these cells will no doubt be watched with considerable interest.

The National Gallery and Electric Lighting.—In the House of Lords on Tuesday Viscount Hardinge rose to move :—"That an humble address be presented to Her Majesty for copy of a memorandum drawn up and signed by the director and trustees of the National Gallery with reference to the risks and inconvenience attending the proposed opening of the Gallery on week days up to 10 p.m." The noble lord stated that the objections of the trustees to opening after dusk were chiefly these :—The electric light was in its infancy, with no guarantee against occasional extinction. Large crowds assembling at night in the Gallery would stir up an unusual amount of dust. The breath of a large number of persons congregated together generates gases which occasion a hurtful deposit upon the pictures, and it is impossible to cover all pictures with glass. With respect to the advantages which would accrue to the working man it was very doubtful whether, after a hard day's work, working men would leave their homes to visit the Gallery.

Electric Lighting in Leeds Town Hall.—Some time ago the Electric Lighting Committee of the Leeds Corporation resolved to illuminate the Victoria Hall by means of arc lamps, at a cost of about £450, in place of the sunlights which form the latest improvement in gas lighting in the hall. It may be recollected that on the occasion of the last Musical Festival, in October, 1883, the hall was illuminated by means of incandescent lamps by Messrs. Crompton and Co. The "electroliers," which are the property of Messrs. Crompton, have not been removed, and if the Musical Festival Committee should prefer the incandescent lamp to the arc lamp, they will be allowed to remain until after the Musical Festival in October next, when the Electric Lighting Committee will proceed to fix the arc lamps. Two arc lamps have just been suspended in the hall, and the Electric Lighting Committee has had an opportunity of inspecting them. So satisfied were the committee with the lamps that others were ordered to be fixed. The installation in its entirety will consist of eight arc lamps, driven by secondary batteries, sufficient for a 10 hours' run, placed in the Municipal Buildings, and the remaining lamps, with the necessary wires, &c., are in readiness to be put up. The lamps are the Brockie-Pell patent. They are fixed upon pulleys, so that they may be varied in height up to 46 feet, and the cleaning and renewing of carbons can be effected by a person standing in the body of the hall. The secondary batteries are charged by dynamos which the Corporation already have in the basement of the Municipal Buildings. The pair of 12-horse (nominal) power Otto gas engines, by Messrs. Crossley Brothers, which supply the dynamo power for illuminating the Public Free Library, are at present standing idle during the day, and can therefore be utilised for the Victoria Hall. The engines are coupled, so that in the event of one dynamo breaking down, the whole of the power could be run upon the other dynamo. The current is carried from the basement of the Corporate Offices to the Town Hall along a subway in Calverley Street, and thence into the false roof of the Victoria Hall, from which the arc lamps are suspended. The work has been carried out under the superintendence of Mr. Hewson, the borough engineer.

Electric Lighting of Railway Carriages.—The *Times* states that it has been decided to extend the system of electric lighting on the trains of the Brighton line generally, so that before long, all passengers by this line may hope to experience the benefit of being able comfortably to read their newspapers during their railway journeys.

Electric Lighting in Rolling Mills.—At a recent meeting of the South Staffordshire Institute of Iron and Steel Works' Managers, Mr. G. B. Wright, of Wolverhampton, read a paper on "The Electric Light as Applied to Rolling Mills," in the course of which he said : So far as direct glow lamp lighting is concerned, it does not appear likely that any considerable advance can be made, and we have in it, beyond question, a steady, reliable, and economic servant. I am in a position to speak confidently of the cost of maintenance, for, in each example given, I have supplied the apparatus, and maintain it under contract, at a price well below the cost of gas.

Courteous Competition.—A novel means of discrediting a rival electric lighting company has been resorted to by the Edison Company in Louisiana, and a means which is unworthy of a corporation engaged in a genuine business. A notice in the terms following was recently distributed by the representatives of the company :—"Electric Light ! The people of Louisiana should be very careful how they hang their faith on upstart electric companies represented by drummers, whose pay depends merely on sales or 'pull-ins.' There are a few companies that have passed the experimental day and can be relied upon. All others should be shunned until they drop the swaddling clothes of experiments, and the Schuyler Electric Company is one of them. W. J. Dougherty. Representing the Edison Electric Light for Louisiana." The Schuyler Company has done a great deal of good work and has acquired a very favourable reputation in the States ; such an exhibition of trade jealousy is not likely to greatly injure its prospects.

Experiments with the Telephone.—Mr. J. S. Holt, of the United Telephone Company, exhibited a number of interesting and successful experiments last week, at the Lecture Hall, in Peckham Park Road. The object of the lecture and the experiments was to raise funds to assist the Society for the Aid of Ladies in Distress, and the audience were highly gratified to find that Mr. Holt, with the assistance of Mr. Crack and several other members of the company's staff, had made elaborate preparations to enable 40 persons at once to use the instruments connected, for the occasion, with a room up the road on the opposite side. An introductory lecture by Mr. Holt, introduced the subject in its technical aspect. The practical demonstration included the following : Into the phonograph during the afternoon a gentleman had played on the cornet "When other lips and other hearts," and the air was reproduced after the evening lecture by unwinding the tinfoil drum. The sound was not greatly diminished, but several of the notes were flat. This, however, might have been the fault of the musician ; or, shall we say, was due to the hitherto undiscovered transposing powers of the apparatus ? The audience were highly delighted. The spoken lines—"To be or not to be," &c., were also re-delivered almost as spoken. The audience were then treated to some vocal music through the Blake transmitter and chalk receiver. The vocalists

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were up the road at the other end of the wire, and the music was transmitted through the "chalk" loud enough for all to hear easily. A vote of thanks to Mr. Holt was carried with loud cheers.

Telephone Extension.—The National Telephone Company is building a telephone line between Glasgow and Kilmarnock.

Telegraphic Addresses.—Writing from the Junior Athenæum Club, W. H. C. says :—"A new word is wanted more suggestive of brevity than the phrase 'Telegraphic address' now being inscribed on our cards and notepaper. How would 'Telenym' do?"

Telegraphic Revenue.—The receipts on the telegraph service, from April 1st, 1885, to March 6th, 1886, amounted to £1,600,000, against £1,610,000 received from April 1st, 1884, to March 7th, 1885.

The Distribution of Electricity.—Has not our correspondent Mr. Jackson mistaken the kind of machines which are employed in connection with secondary generators or transformers? This, however, does not affect his main object in writing to us.

Losses in Electro-Motors.—Mr. Mordey will probably feel interested in the comments made upon his recent paper by Capt. E. Dubois. M. Marcel Deprez evidently has not yet learned the best mode of constructing these apparatus.

Secondary Batteries as Regulators.—We shall be pleased to receive communications from our readers on the subject of Mr. Littleton's letter which appeared in our last issue. Sir David Salomons, with his invariable readiness to assist others, comes forward with facts which we hope may enable Mr. Littleton to remedy the defect of which he complains; others, should such a case have come before their notice, may possibly be willing to give these experiences.

M. Marcel Deprez.—On the first day of the present month M. Marcel Deprez was nominated member of the *Academie des Sciences*. His labours upon the transmission and distribution of electrical energy have been pursued for several years past with a constancy which ought, even if it does not, ensure success. Unfortunately, however, M. Deprez has only succeeded in realising to a very moderate degree in practice that which was already well understood theoretically. Even with the munificent support of M. Alphonse de Rothschild in the Creil-Paris experiments, the results obtained were more discouraging than otherwise. Nevertheless, we congratulate M. Deprez upon the distinction which the *Academie des Sciences* has thought proper to confer upon him, for we believe his talents and energy may yet be turned to better account.

Local Authorities and Overhead Wires.—From our report under the above heading in last week's issue, it will be seen that the Western Counties and South Wales Telephone Company has petitioned to be heard by counsel against the Torquay Harbour and District Bill. The promoters having contested the right of the company on the ground that it has no *locus standi*, this question will be shortly considered by the Court of Referees of the House of Commons, who will decide whether the company can be heard against the Bill on its merits.

Overhead Wires.—Mr. M'Iver asked the President of the Local Government Board, on Thursday last week, whether it was proposed, in dealing with overhead telegraph and telephone wires, to give corporations and urban authorities power to make by-laws or regulations with respect to such wires for the protection of life and property. Mr. J. Collings replied that the Board had no doubt that if a measure were brought in dealing with overhead wires, powers would be conferred on urban sanitary authorities to make by-laws or regulations with respect to such wires.

The New Electric Tramway on Ryde Pier.—A preliminary trial, in connection with the new electric tramway on Ryde Pier, took place on Saturday in the presence of some of the directors and a few gentlemen, who had been invited to be present. The car which was selected for the trial (being the first completed) was in charge of the representative of Messrs. Siemens, under whose superintendence the work of fitting the electric apparatus has been carried out, and its performance was considered to be satisfactory in the highest degree. A light and rather handsome structure has been erected at the south east end of the pier for the accommodation of an Otto gas engine, which indicates 22 horse-power. In the same building is located one of Messrs. Siemens's powerful dynamos, from which the current is conveyed to the west side of the pier, and thence to the train terminus at the pier head, by an iron rod. The return circuit is along the rails, which have been prepared for the purpose. From the side of the car projects a light steel spring, which is brought into contact with the rod, thus immediately completing the circuit and setting in motion the motor. From information supplied to us, and published in our columns on the 5th of February last, the belief might have been established that secondary batteries were to be employed. The above brief description of the actual method of working will, however, disabuse one's mind of any such erroneous impression. It is intended to light each of the cars by means of electricity, which will also be used in the new building. It is believed that the system which is just being inaugurated will prove in the end far more economical, and, at the same time, more efficient than the method of traction which it has superseded. Ryde being situate in one of the most pleasant parts of the Isle of Wight, and being within easy reach of Portsmouth, is visited during the summer by large numbers of excursionists, and no doubt the novelty of a tramway propelled by means of electricity will be an attraction to many persons to ride who might otherwise walk.

A Literary Majority.—Last week the *English Mechanic* entered upon the twenty-second year of its exceedingly useful life, and prominent amongst the contents of the issue is the first of a series of papers by "Xero," on "Practical dynamo building for amateurs."

Society of Arts Meetings.—On Wednesday evening last a paper on "The Experiments with Lighthouse Illuminants at the South Foreland," was read by E. Price Edwards.

Magnetic Screens.—Prof. Anthony, of Cornell University, has published in one of our New York exchanges a short article on "Magnetic screens." This we hope to reproduce in an early issue.

Central Stations for Electric Lighting.—The Edison Central Station in Boston, U.S.A., is being rapidly pushed forward. It is intended to start with 2,000 lights, to be increased eventually to 6,000. These will be used by the theatres, stores, and hotels in the vicinity, and the wire will be run underground.

The Electrical Transmission of Power.—The papers read at the Baltimore Convention, several of which were reproduced in our issue of last week, brought out with great force, says the *Electrical World*, the probable future of electric light stations. In the near future, every dynamo plant will be a lighting station at night and a power station during the day.

The Edinburgh International Exhibition.—It was reported at the last meeting of the committee of the International Exhibition that Messrs. Arrol & Co., Glasgow, have generously offered to erect an iron bridge to cross over the court for the machinery in motion, extending to 400 feet eastward by 150 feet. The electric lighting of the main avenue, which requires 1,444 incandescent lamps to light it up was stated to be in a forward condition.

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A New Turbine.—A new turbine of American design is illustrated in the *Electrical World* for February 27th. The wheel is made in one casting, without bolt or rivet, possessing, therefore, great strength. It is also formed so as not to be liable to clogging, and is designed to give maximum efficiency with every position of the gate.

Dynamo Testing.—We would call attention to the contribution to our "Correspondence" columns from the pen of Captain P. Cardew, R.E., on the subject of testing dynamo-electric machines, and we should still be pleased to receive any criticisms on the method introduced by Dr. Hopkinson for testing the Edison-Hopkinson dynamos.

The suggestion made by Lord Rayleigh and the practice of Captain Cardew will doubtless commend themselves to Dr. Hopkinson, and may we not in further experiments look for still higher efficiencies? We would, however, remind our readers when comparing data obtained with different machines, that small motors of from ½ to 4 or 5 horse-power, and with considerable internal resistance, must not be placed in the same category with a 50 H.P. Edison-Hopkinson dynamo.

Obituary—Auguste Guerout. — We regret to announce the death of M. Auguste Guerout, for the past five years editor of *La Lumière Electrique.* After finishing his university life in France, he studied first at Goetingue under Prof. Woehler, then at Manchester in the large chemical works of Mr. Grace Calvert, where, in addition to completing his technical education, he acquired a knowledge of the English and German languages. On returning to Paris he entered the laboratory of Antoine Cæsar Becquerel, and afterwards accepted an appointment in the firm of Ruhmkorff. At this time he contributed articles to *La Lumière Electrique*, the editorship of which was offered to him towards the close af the year 1880. He died at the village of Sainte-Croix-Montvilliers (Seine Inférieure), on the 28th day of February, after a long illness.

Torpedoes Electrically Steered.—The Edison Machine Works of New York are, it is said, building for the U.S. Government a number of electrical torpedoes. These are propelled, steered and exploded from the shore by electricity. For the purpose of steering two powerful electromagnets are placed in the after part. When the torpedo is going straight ahead the rudder is held in the centre, but by the operator moving a small lever on shore the current passes from one electro-magnet to the other, and the rudder is put over in the required direction. A speed at the rate of over 11 miles an hour has been reached on government tests, but it is expected that this will be exceeded. The charge consists of 400 pounds of dynamite. These torpedoes have been tested by being anchored in front of a fort and kept under a concentrated fire for hours, until the float has been completely riddled, and they have yet been ready for active service.

Marriage of Mr. Edison.—Mr. Thos. A. Edison was married to Miss Mina Miller, of Akron, Ohio, on February 24th, Lieut. F. W. Tappan, U.S.N., acting as groomsman. Mr. and Mrs. Edison will spend the winter months at the groom's Florida home.

Arago.—The celebration of the centenary of Arago which has lately taken place at Perpignan under the auspices of Mons. Granet, Minister of Posts and Telegraphs, may render a short account of this celebrated scientist of some interest. François Arago was born at Estagel on February 26th, 1786, and was educated at the College of Perpignan. At 17 years of age he was admitted into the Polytechnic School after a most brilliant examination. Notwithstanding his political opposition to Napoleon, the Emperor in 1806 selected him, in conjunction with Biot, to carry out certain meridional measurements upon which the metrical system is based. During these operations Napoleon declared war against Spain, and Arago after having been a prisoner of war, captured by a privateer, confined on a hulk, and passing through numberless adventures, managed to return to France, having saved his instruments and papers. At the age of 23 he was Member of the Academy of Sciences, Professor at the Polytechnic School, and a little later Director of the Observatory. One of his most remarkable attributes was the wonderful simplicity of his language and the ease with which he gave popular explanations of the most difficult problems, the most abstruse theories or experiments. His lectures at the Observatory were followed with the greatest interest by old and young, scientists and ladies of fashion. He took some share in politics, being elected Deputy for the Pyrenées Orientales, in 1830, but did not succeed very well, being probably too plain spoken, for his political opinions, although he belonged to the extreme left, were the real cause of the present Municipal Council of Paris refusing to participate in the celebration. When 44 years old he was elected as Life Secretary to the Academy of Sciences. Although he refused allegiance to the Second Empire, the admiration of his worth and his scientific attainments was so great, that he was allowed to enjoy his various appointments and the honours and dignities showered upon him by nearly the whole of Europe. He died in 1853, at the age of 67.

Comparisons in Electric Lighting.—The recent experiments of the Franklin Institute upon incandescent and arc lights, according to *Science*, give the following averages:—One pound of anthracite burned under a good boiler yields, in the incandescent system of lighting, about 40 candles; the same weight of coal gives from the naked arc light about 158 candles; ordinarily arc lights are shaded so as to lose about one-half their intensity, so that only 80 candles per pound of coal are available; one pound of bituminous coal will yield from five to six cubic feet of illuminating gas; this gas will, in the standard argand burner, yield from 14 to 17 candles. Illuminating gas is burned at once in the simplest manner, and the amount of machinery and care required by electric lighting offsets its greater economy of fuel, light for light. There is little room for improvement in dynamos, but the most important economies will arise from more skilful use and design of the steam engines required to drive the dynamos. The steam engine, although much the senior of the dynamo in the list of inventions, is not nearly so well understood. It is but very recently that the laws of condensation and expansion of steam in the engine actually at work have been grasped, and our limitations so clearly defined as to point out the logical way to greater economies, and prevent us from attempting economy under impossible conditions.

A Prosperous Company.—The Middlesex Electric Light Company, of Lowell, Mass., is said to be one of the most prosperous corporations of the kind in the States. The station of the company is one of the most conspicuous and attractive buildings in Lowell; and the entire equipment of the plant, from its enormous 250 horse-power engine down to the smallest dynamo, is first-class in every respect. The wiring and poles throughout the city indicate the handiwork of skilled linemen. The system in use is the Thomson-Houston, and the 273 arc lights (3,000 candle-power), all of which have been running for several months, have given thorough satisfaction. Orders are in the hands of the company for many more lights, and the manager has been constantly pressed of late to add an incandescent plant to the station—upward of 1,000 lamps being already guaranteed.

The Electric Carbon Storage Company of Scotland, Limited.—It will be in the remembrance of those interested, that two dividends have already been paid in this liquidation matter, amounting together to ten shillings in the pound, and we have pleasure in an-

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nouncing that the stumbling block to a possible further payment has now been removed. The mortgagees claimed the whole of the proceeds from the sale of the assets in Scotland, they holding a mortgage on the machinery and fittings for £2,000 from Mr. Hope. The Liquidator proposed to dispute this claim, which would have been a difficult and expensive matter, and involved a conflict between the English and Scotch law relating to the rights of mortgagees. An agreement has now been submitted to, and has been confirmed by, the Court, compromising the claims of the mortgagees for £500. The result of this is that the Liquidator will now be in a position to at once ascertain the costs of the liquidation, and declare a final dividend, which he hopes to make at least five shillings in the pound.

The Electric Light at Lloyd's.—The extensive suite of rooms occupied by Lloyd's in the Royal Exchange has been successfully lighted by electricity by means of storage cells, the installation constituting, according to the *Times*, the most recent example of interior electric lighting and possessing several special features. The machinery and apparatus are placed in two large vaults in the basement of the Exchange, the current being produced by means of two Elwell-Parker four-pole shunt-wound dynamos, each giving 200 ampères and 75 volts. These machines are driven at a speed of about 600 revolutions per minute direct from a Davey-Paxman compound semi-fixed engine of 20 horse-power nominal, but which is sometimes worked up to 45 horse-power. This plant supplies the current to about 400 Edison-Swan glow lamps, each of 10 candle-power and 50 volts. The installation was completed and the lighting began towards the close of last year, and proved most successful in all respects save one. Soon after the start objection was taken by some to the noise and vibration, supposed to have been caused by the engine, which, however, is very quiet and steady in running. Be that as it may, all cause of complaint was removed by the introduction of storage cells, which are charged from the dynamo before and, if necessary, after business hours. The battery room adjoins the dynamo room, and in it are compactly arranged two sets of accumulators, each set being composed of 29 batteries, and each battery consisting of three cells joined in parallel, giving 180 ampères. The 29 sets of threes are joined up in series, giving 58 volts. There is therefore a total of 174 cells. They are all the Electrical Power and Storage Company's cells of the latest type, and the combined accumulators when fully charged are capable of supplying the current to the whole of the lamps for about eight hours. Between the dynamos and the batteries is an Elwell-Parker automatic cut-out by means of which the return of the current to the dynamos is prevented should their rate of working fall below the normal speed. The conductors from the batteries to the lamps are carried in separate troughs, and safety fusible plugs are used throughout. The whole of the current is manipulated from two main distributing switch-boards which were designed by the Electrical Power and Storage Company, and which afford facilities for varying the number of cells, both in the charging and discharging circuits.

Self-Induction in Conductors.—We understand that Prof. Hughes will endeavour to answer all questions relative to his paper, recently read before the Society of Telegraph-Engineers and Electricians, in the *Journal* of that society. It would not be fair to those who took part in the discussion if the Professor answered queries indiscriminately in the various technical journals.

Economy in Electrical Conductors.—We are reluctantly compelled, through pressure on our space, to leave over the papers read last night before the Society of Telegraph Engineers and electricians, which include an important one on "Economy in Electrical Conductors," by Profs. Ayrton and Perry.

The New York Electrical Society.—At the last meeting of this society, Mr. Henry D. Hall, the inventor of an ozone machine, delivered an interesting lecture upon the generation of ozone by statical electricity. The meeting was held in the rooms of the Ozone Machine Company, in the *Post* building, in Broadway, and the modified Holtz machine employed was run by an electro-motor connected to the Edison electric light circuit. Mr. Hall, after describing the principles of his machine, gave a *résumé* of the uses to which ozone can be applied in the arts and in medicine, and demonstrated its utility for numerous purposes.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Standard Electric Light and Power Company, Limited.—The annual return of this company, made up to the 15th April, 1885, was filed on the 8th inst. The nominal capital is £300,000, in £10 shares. 9,707 shares have been taken up, and upon seven of these £1 per share has been called, the remaining shares being considered as fully paid up. The calls paid amount to £6.

Byng Telephone Company, Limited.—The registered office of this company is at St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.

Railway Electric Lighting Company, Limited.—The business, &c., taken over by this company is purchased upon the terms of an agreement with the Railway Electrical Contractors, Limited. The consideration is £30,000, payable £12,000 in cash, 1,200 fully paid shares, and £12,000 by the allotment and issue to the members of the old company of 4,800 shares credited with £2 10s. as paid upon each; and for the purpose of determining the stamp duty payable on the assignments of the English patents, it is agreed that the sum of £1,000 shall be taken as consideration for the assignment of each of such patents.

Davis and Timmins, Limited. — The registered office of this company is now situate at 24, Charles Street, Hatton Garden.

J. E. H. Andrew and Company, Limited (gas and electrical engineers).—An agreement dated 19th ult. and filed on the 3rd inst., regulates the sale to the company of the patents and business of J. E. H. Andrew and Co. for £11,280, of which £6,000 is payable in fully paid shares. Mr. Hugh Williams, C.E., of Lyme Street, Stockport, is appointed consulting engineer to the company.

CITY NOTES, REPORTS, MEETINGS, &c.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited.

At an extraordinary general meeting of this company, held at the Offices, 106, Cannon Street, E.C., on Tuesday, the following resolutions, which were passed at an extraordinary general meeting held on February 18th, were submitted for confirmation, and were confirmed:—

"1. The board of directors may from time to time appoint one of their number or any other person to be a managing director of the company, and may determine the amount of his remuneration and the terms of his engagement, but no such engagement shall be for a longer period than five years. A managing director shall not retire from office by rotation during the period of his engagement.

"2. The number of directors (including any managing director) shall not exceed seven nor be less than four, and every director shall hold at least 100 shares in his own name as the sole holder thereof. The directors may from time to time appoint any additional directors or director, provided the number of directors shall never exceed seven.

"3. The remuneration of the directors other than a managing director shall be from time to time determined by the members at the ordinary meeting; but any proposal for the alteration of the remuneration of directors shall be deemed special business, requiring seven days' notice to be given thereof.

"4. The directors may from time to time sell, lease, exchange, or otherwise dispose of and deal with all or any parts or part of the property of the company situated in France upon such terms and in such manner as they may think expedient."

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Mr. Cater, a shareholder, on the proposition for the confirmation of the third resolution, said he saw by the balance sheet that the minimum remuneration of the four directors was £2,000, and the extra remuneration was £2,695, giving each director £1,173 18s. 10d¼d. If the number of directors was to be increased to seven, including the managing director, then the amount would be, at the same rate, £6,874 1s. 7d., and if the managing director was to receive more than the others, the sum would be still larger. He held in his hand the balance-sheet of the Telegraph Construction and Maintenance Company, which transacted a very similar business, and from that he found that the board of that company consisted of six directors and the managing director, and the remuneration they received was £2,000, with £1,991 as extra remuneration, giving £570 2s. 10½d. each. Could any explanation be given on this subject?

The Chairman said the answer was, that the *maximum* remuneration to be paid the directors was £5,000, according to a motion passed some years ago, and which would not now be interfered with, whatever the number of directors might be.

Mr. Cater then desired to know whether the managing director's remuneration was included in that sum, and when informed that it was not, asked what that gentleman would be paid.

The Chairman replied that that question was discussed at the last meeting, and the shareholders decided that it was not desirable that the amount which the managing director would receive should be made public.

The resolutions were all unanimously confirmed, and the meeting separated after a vote of thanks to the chairman.

The National Company for the Distribution of Electricity by Secondary Generators.

The report of the directors states that the anticipation of a profitable business, which they ventured to express in the report presented to the shareholders at the general meeting held on the 9th of February, 1885, is being realised.

The seven months of 1883, and the whole of 1884, formed a period of preliminary work, undertaken with a view to demonstrate the company's system. The amounts expended on the trial installations on the Metropolitan Railway and at Turin, though large, seem to have been fully justified by results.

The accounts submitted to the meeting show a profit of £4,570 10s. 7d. after deducting all expenses. After writing off from this balance £574 4s. 2d. for depreciation of plant and a proportion of preliminary and other expenses, there is a net balance of £3,996 6s. 5d., out of which the directors propose to pay a dividend on the preferred shares at the rate of 10 per cent. per annum, from the respective dates of allotment to the 31st December, which will absorb £2,207 6s. 4d., leaving to be carried forward £1,789 0s. 1d.

An amount of £1,087 16s., received from the Banque d'Escompte de Paris on the 13th of February in this year, as balance of the guaranteed minimum for the year ending 1st February, 1886, does not enter into the 1885 accounts, although 11-12ths were really earned in 1885.

The installation at the mines and works at Aschersleben, in Germany, has been in operation for a considerable period, and is being extended. The installations at Turin and Tivoli, though progressing satisfactorily, are less advanced. The profits of these works will appear principally in the accounts of the current year.

The directors, therefore, have pleasure in pointing to the fact that the profits for the current year have already a considerable basis from matured business, while the prospect of new business is promising from several quarters.

The directors have pleasure in announcing the conclusion of a contract with Mr. George Westinghouse, jun., of Pittsburg, for the working of the company's patents in the United States of America. The character and position of Mr. Westinghouse justify the expectation of important results from this arrangement. As in the case of the Banque d'Escompte, Mr. Westinghouse guarantees a minimum annual return to the company.

The shareholders are probably aware that a gold medal was awarded to the company at the Inventions Exhibition, South Kensington, "for the successful working out of a system of distribution of electricity by induced currents."

The installation at the Grosvenor Gallery, undertaken by Sir Coutts Lindsay and Company, is not yet complete. In regard to this installation, the company has no responsibility beyond the supplying of their apparatus.

The successful opening of the installation at Tours, under the direct supervision of the chief engineer of the company, has produced a marked impression in France, and promises to lead to a large employment of the system there.

In order to enable the payment of the dividend now recommended, without crippling the resources of the company, the directors waive their claim to remuneration up to the end of 1885.

The directors believe the time is not far distant when a dividend on the ordinary shares may be looked for; they base this expectation on the growing appreciation of the system by scientists and the public.

Mr. D'Oyly and Sir J. Mackenzie, the directors who retire by rotation, offer themselves for re-election. In pursuance of Article 70, Mr. Gustav Defresne was elected to fill the vacancy on the board of directors occasioned by the death of Mr. Le Fez; this appointment will be proposed for confirmation. Mr. J. H. Thornton, the retiring auditor, will be proposed for re-election for the current year.

The Liverpool Electric Supply Company, Limited.—The directors, in presenting their annual report, recommend a dividend at the rate of 6 per cent. on the paid-up capital of the company. The dividends for the two previous years, 1883 and 1884, were at the rate of 5 per cent. per annum. The report states that, in addition to the contract for the whole of the electric lighting of the Liverpool International Exhibition, the company has other important orders in hand, and arrangements are in progress for a large extension of electric lighting from the company's central supply stations.

The Western Union Telegraph Company, Limited.—A Reuter's telegram, dated New York, March 10th, states that the Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent., payable in scrip. According to the financial article in the *Post* it appears that the company has not earned the last two dividends, and that the scrip dividend is due to the decrease in revenue and the increase in expenses for taxes and repairs.

Western and Brazilian Telegraph Company, Limited.—The *Times* of Thursday states that on the previous day Western and Brazilian Telegraph shares were largely bought on rumours that the negotiations with the Brazilian Government are making satisfactory progress. The ordinary shares advanced ⅛ to 7 $\frac{9}{16}$, and the deferred $\frac{5}{16}$ to 3¼.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 5th were £2,724, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for February, 1886, were £18,800; from January 1st to February 28th, 1886, £38,680; in corresponding month of 1885, £41,200; and of 1884, £38,680.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending February 28th were £3,300.

The Brazilian Submarine Telegraph Company, Limited. The receipts of last week amounted to £3,357.

NEW PATENTS—1886.

3053. "Electric arc lamps." W. L. Wise. (Communicated by G. Mariotti.) Dated March 3.

3106. "Electric and magneto bells and apparatus to be used in connection therewith." H. P. F. Jensen, J. Jensen, B. W. Webb. Dated March 4.

3125. "Apparatus for measuring currents of electricity." S. Sudworth. Dated March 5.

3133. "Electrical conductors." W. R. Lake. (Communicated by H. A. Clark.) Dated March 5. (*Complete.*)

3135. "Electric cables." W. R. Lake. (Communicated by H. A. Clark.) Dated March 5. (*Complete.*)

3149. "Incandescent electric lamps." A. Bernstein. Dated March 5.

3182. "Cure of liver and stomach complaints through the action of an insulated voltaic electric chain belt." W. Laughton. Dated March 6.

3183. "Dynamo-electric machines." T. A. Garrett. Dated March 6.

3184. "Prismatic and magnetic compasses." J. H Steward. Dated March 6.

3199. "Telephones." J. Stuart. (Communicated by G. Hutinet and P. Felix.) Dated March 6.

3235. "Absolutely continuous current dynamo-electric machines." C. J. Hall, W. Lawrie. Dated March 8.

3240. "Use of electric search light apparatus in an improved way for navigating the Suez Canal and other narrow waters by night." C. Hall. Dated March 8.

3253. "Conversion of electric currents and apparatus therefor." H. H. Lake. (Communicated by F. Heimel and F. Waldmann.) Dated March 8.

3260. "Current regulating apparatus for use in electric arc lamps, &c." H. H. Lake. (Communicated by F. Heimel and F. Waldmann.) Dated March 8.

3323. "Electric flash-signalling apparatus." E. S. Bruce. Dated March 9.

3334. "Electric arc lamps." R. H. Courtenay. Dated March 9.

3335. "Appliance for preventing overhead broken telegraph and telephone wires from falling and causing injury to life and property, applicable also to clearing the wires of snow." J. M. B. Baker, H. E. Pollard. Dated March 9.

3340. "Electric arc lamps." W. H. Trentham. Dated March 9.

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CORRESPONDENCE.

Self-Induction.

Every listener present at the discussion which followed Prof. Hughes's most excellent paper must have admired the discourses, in which one professor after another endeavoured to prove mathematically that he knew more about the coefficient of self-induction than the previous speaker. And although, as Lord Rayleigh remarked in opening the discussion, Prof. Hughes meant something else by self-induction than Clerk-Maxwell, and although Prof. Ayrton chided all previous speakers for having lost sight of the main issue of Prof. Hughes's dissertation, yet one and all made the coefficient of self-induction *in a coil* "the burden of their song" (except Prof. Fitzgerald, who, to the satisfaction of everybody present, proved the existence of magnetism before it was born).

Such enthusiasm in the development of the science of electricity is catching, and to assist in the endeavour to make the subject still plainer and easier to understand, I beg to submit for the edification of your readers the following formula for the *coefficient of self-induction in a coil*, as given in Prof. Weidemann's "Electricity," vol. 4, p. 84 :—

$$P = n^2 F\left(\frac{b}{c}\right) = 4\pi a n^2 \left\{ log.\left(\frac{8a}{c}\right) + \frac{1}{12} - \frac{\pi}{3}x - \frac{1}{2} log\,(1+x^3) + \frac{1}{12}\frac{1}{x^2} log\,(1+x^2) + \frac{1}{12}x^2 log\left(1+\frac{1}{x^2}\right) + \frac{2}{3}\left(x-\frac{1}{x}\right) arc\,tg\,x \right\}$$

For very exact determinations the following expression must be added: $n^2 f\left(\frac{b}{c}\right)$, in which is:

$$f\left[\frac{b}{c}=x\right] = \frac{\pi c^2}{24a}\left\{\left[log\left(\frac{8a}{c}\right) - \frac{1}{2} log.\,(1+x^2)\right](1+3x^2) + 3{\cdot}45\,(1+x^2) + 27{\cdot}475 - 1{\cdot}6\,\pi x^3 + 3{\cdot}2\,x^3 arc\,tg\,x - \frac{1}{10}\frac{1}{x^2} log\,(1+x^2) - \frac{13}{6}x^4 log\left(1+\frac{1}{x^2}\right)\right\}.$$

This, I think, is very simple, simple enough for any tyro who wishes to find the coefficient of self-induction in the coils of his telegraphic instrument or of the revolving armature of his dynamo; and if not simple enough, he must be a rare simpleton not to be able to use it.

And if it cannot be admitted that this formula is plainer, no one will deny that it is longer (and hence more convincing) than either of those given by the Professors at the meetings, to prove what the President in his paper never attempted to prove, the coefficient of self-induction in

A Coil.

[We consider that our correspondent will earn the gratitude of all seekers after the truth by his contribution to the literature of such an interesting subject. Although the extract to which he refers does not figure in the paper of Prof. Hughes, that is not the fault of Herr Wiedemann. It is a mistake to write in simple language; the author's meaning is apparently less readily grasped and much confusion is the result. —EDS. ELEC. REV.]

American Telephone Patents.

I send to the REVIEW a very important letter bearing on the telephone case, written by an eminent jurist, parts of which may be interesting to your readers.

I have been permitted to read the evidence which was submitted to Secretary Lamar in this case, and I must acknowledge that I failed to find any proof of fraud on the part of Bell or his agents in obtaining his patent of March 7th, 1876, and I hold the opinion that there is no statute which authorises the Government to institute a suit to vacate a patent on any ground that could be pleaded by an individual when sued for infringing that patent; the allegation of fraud in obtaining the patent seems to be one which an infringer cannot plead in defence, but it would seem that the Government must have the right to punish fraud, when committed against it; hence, I infer that the Government can bring a suit to annul a patent on the allegation that it was obtained by fraud, and on that allegation *only*, and on no other. In this case, as it now stands, so far as I can judge of evidence, there is none whatever which proves fraud.

Questions of priority of invention cannot, in my opinion, be tried by a suit brought by the Government. Infringers, when prosecuted, can set up priority of invention. The "hue and cry" against the Bell patent in this country emanates from *would-be* inventors, who have failed to invent a telephone which will work without the use of an undulatory current, or to speak more scientifically, which does not require a *closed circuit;* and the clamour is propagated throughout the land by speculators and owners of shares in speculative companies.

In order to create in the public mind a feeling against the Bell patent, these speculators are continually publishing that Judge Lowell, in his decision in the case against Spencer, June 25th, 1881, decided that Bell's patent covered "the art of transmitting speech by electricity," and, therefore, that no telephone could be made or used in the United States. Now I quote the following from that decision:—

"Bell has the right to hold the broadest claim for it, which can be permitted in any case, not to the abstract rights of sending sounds by telegraph without any regard to means, but to all means and processes which he has invented and claimed."

Mr. Bell certainly was the first to use a *closed circuit* (or undulatory current), and he has a right to it as he claimed it in his patent.

W. C. Barney.

Washington, *February* 19*th*, 1886.

Secondary Batteries as Regulators.

In reply to Mr. Littleton's query in your last issue as to the cells failing to act as regulators under certain conditions of charge and discharge, I think he will find that this is no abstruse electrical phenomenon, but merely a bad contact somewhere in the accumulator branch. This is borne out by the fact that Mr. Littleton can only get this effect on some nights and not on others.

As it is now an admitted fact that accumulators are by far the most efficient and reliable form of regulator in connection with gas engines or other unsteady sources of power, I should be sorry for your readers to be led to think that there was an electrical condition of balance at which the accumulators failed to steady the light, as in no single installation has this ever been found to be the case, and I think that if Mr. Littleton will go carefully through his connections the phenomenon will disappear.

Bernard Drake, *Managing Engineer.*

Electrical Power Storage Co., Limited,
London, E.C., *March* 10*th*, 1886.

I am writing in reply to a letter you published from Mr. Littleton.

It is a perfect fallacy to suppose that a secondary battery steadies the E.M.F. in the lamp circuit when the motor is not regular in its speed. The steadying influence only comes into play subject to the various conditions which I placed before the Society of Telegraph Engineers and Electricians in a paper read at their meeting of March 12th, 1885, and enclosed you will find a copy.

Mr. Littleton's data are too scanty to form any opinion as to what is at fault, but whatever the reason may be (if not from bad contacts), it can be found out if this paper is referred to. The probable reason is that the "curve" of the dynamo has some peculiar character not suitable

to the installation, and the resistance of the cells and leads is too high.

Why an accumulator as a rule makes a good regulator is due to the fact that the conditions required to this end usually exist more by accident than intention, for the better the dynamo (from an electrical point of view) the worse is the regulation; and finally, if the machine were perfect the cells would be of no avail whatever for regulation. When the paper referred to was read, I was "called to task" for stating that "a momentary fall in the speed of a pure shunt dynamo causes a rise of E.M.F." It is perfectly true, nevertheless, the rise lasting but a moment; it was, therefore, with great pleasure that I read Prof. Hughes's recent paper on his new discoveries, for they confirm the point which I had observed by making it capable of explanation, and it shows that it is not always safe to ridicule as it may often show ignorance, unless the facts are first investigated. At first sight it might appear that perpetual motion was discovered, but if the sum of all the differences of E.M.F. over a given time are added together, no such new discovery is there. It seems extraordinary to me that so few people are giving real attention to the various relations which exist between dynamo, cells and line, for some statements and also results I have heard and seen are astonishing, and then the results are laid down as a law, whereas in all cases the results have been accidental, and some disappointment will necessarily arise where more efficient dynamos are used, for all the results now put down as law will vanish. The modern dynamos here have proved this long ago, so will common sense if properly applied. I especially refer to the general idea, entertained even by many experts, that the cells act as a regulator under all circumstances, if fairly large, and that the E.M.F. of the dynamo will always accommodate itself to any number of cells, subject only to its being high enough in the first instance to charge the total number in the battery. Both these notions are absolutely wrong, from beginning to end, if the dynamo is a perfect machine electrically, or even approaches this state.

David Salomons.

Broomhill, Tunbridge Wells.

[The paper to which Sir David Salomons refers was published in the Review at the time of its delivery. Sir David apparently contradicts himself in the beginning of the second and fourth paragraphs respectively. —Eds. Elec. Rev.]

Mechanical Telephones.

You have so often used your pages to warn the public against useless investments, would it not be wise to do so again in the case of a new Mechanical Telephone Company, announced in your journal recently; or, if you prefer not, could you inform me how the company is expected to earn dividends from the sale of an article which is in no way superior or cheaper than those offered by many other makers (and have been for years), and which can be beaten in cost of production by private firms easily?

Enquirer.

Theory respecting Faults in Incandescent Lamps.

I have read your article in last week's issue disclosing the opinion of M. Felix Lucas upon the above important subject with very great pleasure, more especially as it coincides to a very great extent with my own views upon the subject. At the same time, permit me to say, that I am afraid no lamp maker will ever be able to produce a more perfect vacuum than that now attained, until our glass manufacturers can devise some means of producing a perfectly non-porous glass; as undoubtedly it is to this cause that the life of so many lamps are shortened, as the vacuum however good it may be, in a newly made lamp, becomes changed when in use by absorption and expansion of the bulbs under different atmospheric conditions; consequently, great care should be taken in the selection and quality of glass used for lamps. Monsieur Lucas appears to have entirely overlooked this latter point, which to my mind is a very important one, and well worthy of scientific research.

In the year 1881 I began to study the defects in incandescent lamps, and noticed that in both the Edison and Swan lamps there was a great tendency of the globes to become blackened after being in use a short time. The Swan more so, owing to the porosity of the glass used, this blackening increasing considerably as time went on. I also discovered in the course of my experiments, that this deposit which is so detrimental to the appearance of the lamps, considerably increases when same are run beyond the actual resistance of the filament and normal C.P. of lamp; when this is done, it causes a gaseous vapour to be thrown off by the action or disintegration of the carbon filament, much more so when these are composed of carbons of a porous nature, prepared of such materials as cotton, silk, cane or vegetable fibres, all of which appear more subvert when extra current is flowing through them. To overcome this difficulty, which is clearly set forth in my patent of 1883, I introduced a carbon filament prepared entirely upon a different mode to that of either Mr. Edison, Mr. Swan or other makers, using as a basis for the new filament, pulverised moss brought into a cellulose state, and saturated with a weak solution of gum, sugar and soot prior to carbonisation; by this mode the filaments are much more dense and less absorbent of the gas used in course of manufacture, consequently purer filaments are obtained, which also give more brilliant light and last longer.

I have been frequently asked by electricians why I adopted the chamber in the neck of the bulb of our lamps; singular to say, I did so amongst other reasons to partly overcome the very defects pointed out by M. Lucas, which fault occurs in nearly all other lamps in the market except those sold by our firm and those of certain makers having a right to use this part of my patent, which is evidently a good point gained, or so many infringements would not have been attempted which in due course will be checked, as it is not my intention to remain passive for ever.

This small chamber in the neck was first introduced by me to act as a receptacle for the gaseous vapour emitted from the filaments, which causes minute infusible molecules of carbonic vapour, which float about in all bulbs of imperfect vacuum, and this gaseous vapour naturally ascends to the highest part of the bulb and deposits itself, first in the receptacle, prior to obscuring the transparency of the entire globe. Thus globes made upon my principle will be found to keep clear much longer than bulbs of ordinary shape used by so many makers.

The present system adopted by us all in manufacturing glow lamps is undoubtedly wrong, both in theory and practice, and certainly the most expensive that could be devised; and in order to meet the future demands of the million for placing cheap lamps in the market, other methods must be resorted to, and something entirely new produced, so as to come within the reach of all, as the demand for lamps is certain to come in due course.

I have always been, as is well known, a believer in low resistance lamps, although others differ from my views; it is, therefore, very pleasing to me to find several makers now following in my steps, by making lamps according to my theory of a volt per C.P.

It may, therefore, interest your readers to know that I have been experimenting for some months past entirely in a different channel, to still further develop the value of glow lamps, and I hope at an early date to be able to place in the hands of electricians a reliable 1,000 hour *low resistance lamp*, which they will be able to sell at about half the present price now charged to the consumer, and with your kind permission, I may have something more to say upon the above subject at a future date.

Arthur Shippey.

13 & 14, King Street, Cheapside, E.C.

[We shall be pleased to learn that Mr. Shippey has succeeded in producing good yet cheap lamps; but one

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or two points in his communication lead us to the belief that he is not treading on safe "electrical" ground. Other manufacturers will doubtless form their own opinions on the views above set forth. We presume that Mr. Shippey in speaking of lamps being run beyond the actual *resistance* of the filament, intends to convey the meaning of resistance to rupture. —EDS. ELEC. REV.]

Secondary Batteries.

Will any reader inform me as to the merits of the De Khotinsky cell? Wherein is the difference between the E.P.S. and itself, or any other well-known form? I have heard its efficiency in ampère hours is 90 per cent., provided that the charge and discharge does not exceed a certain ampèrage per pound of lead. What does this pound of lead mean? Is the active, as well as the inactive, to be considered? I should very much like to know where one or more of these cells could be inspected.

R. Mitchell.

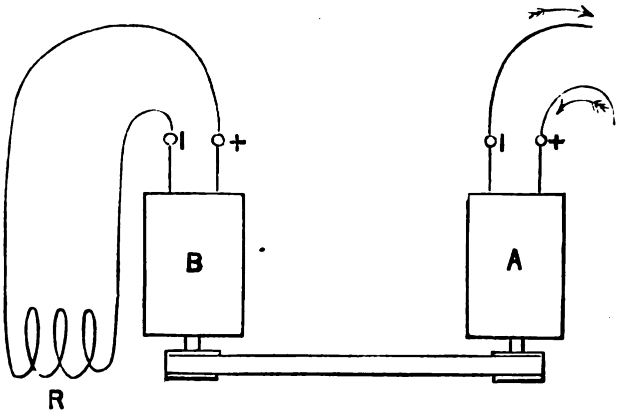
Walham Green, S.W.

[We would refer our correspondent to the articles of Mr. Reckenzaun in our last and present issues respecting the performances of secondary cells. Perhaps some of our readers may have had experience with the De Khotinsky batteries.—EDS. ELEC. REV.]

Dynamo Testing.

With reference to the method of measuring efficiency of dynamos proposed by Dr. Hopkinson, F.R.S., and described in your last issue, it may perhaps be of some interest if I state the method devised by me some time ago, and now regularly employed in testing machines supplied to the War Department.

It much resembles Dr. Hopkinson's, but the machines are connected together by a short piece of belting; one connected as a motor is supplied with its proper current and difference of potential from a third machine, which need not be of similar pattern, but must of course have sufficient power; the other is connected to a variable resistance and generates a current.



The accompanying diagram explains the arrangement, A being the motor and B the generator, R the variable resistance.

The test is as follows:—

The proper volts being supplied to A, R is varied until the current in A equals that specified for the machine. The volts and current given to A are measured simultaneously with the volts at the terminals of B and the current given out by it, when P the power absorbed in A must bear a certain proportion to P^1, that given out by B.

At first, in order not to frighten contractors by this test, P^1 was only required to be $= \frac{P}{3}$.

Even this very moderate requirement, however, caused some uneasiness, and the electricians of a certain well-known company protested that their machines were not designed as motors. However, when they tried it, and found that they easily exceeded the requirement, they ceased to asperse their machines, and, indeed, have since discovered that these same machines are exceptionally efficient motors.

The advantage of the test is, that no measurements except electrical ones are required, and if the instruments used are at all doubtful the same instruments may be used for the two circuits, alternating them by means of switches.

I was led to adopt it by the doubts I have always felt of dynamometer measurements, which are perhaps all very well for one's own amusement and edification, but would certainly lead to difficulty between two parties interested in the result. The unsettled condition of the electrical units, and of the calibration of instruments, also decided me to adopt a method which is quite independent of the absolute value of the volt and ampère, or of the markings on an instrument, so long as it is fairly consistent with itself.

I do not find any objection to the test now on the part of contractors, although I have raised the efficiency required.

I hope when occasion serves to extend this method of measuring the power absorbed by a motor to exactly measure the power lost in countershafting, long belts, &c., which should, I think, give valuable results.

Dr. Hopkinson's arrangement is certainly most ingenious and complete, but as the loss is measured on a mechanical dynamometer, it would hardly, I think, answer the same purpose as my test.

P. Cardew, *Capt. R.E.*

Chatham, *March*, 1886.

In the measurements of the efficiency of dynamos by Dr. Hopkinson's ingenious method, would it not be possible to carry out the principle more fully, so as to dispense with *all* measurement of mechanical power, by introducing into the circuit a few storage cells which should supply the small percentage of energy wasted. In this way all the data could be observed electrically.

Rayleigh.

Athenæum Club, Pall Mall, S.W.,
March 9th.

The FitzGerald Secondary Battery.

It would appear, from the note on p. 215 in your last issue, that M. Hospitalier accuses me of making use of his name, and of doing so in an unjustifiable manner. I have written to demand that he shall at once retract this allegation or inform me of the grounds on which it is made. Until I receive his answer I shall forbear from characterising his conduct in this matter.

In the meantime, I think there is little danger that those who know me—and who know of my position in relation to the commercial working of my inventions—should think me capable of making the statements complained of. These—which might be merely mistakes on the part of others—would in my case involve direct (and very foolish) falsehood, since I happen to be aware that, for reasons best known to himself, M. Hospitalier has kept back his expected report on the results of his experiments with my battery, and since these results are well known to many persons besides myself, M. Hospitalier, I think, considerably overrates my estimate of his importance in relation to the battery, which latter—more especially in its improved form—will be well able to speak for itself when it gets into other hands.

Desmond G. FitzGerald.

Charge and Discharge Indicators for Secondary Batteries.

As secondary batteries are now attracting the serious attention which might long since have been well bestowed upon them, consideration is naturally being given to the various devices which, under extended conditions of employment, become essential for their regulation and control.

Notice has lately been especially directed to the necessity of having at hand some simple method for

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arriving at their state of charge and discharge, and for automatically cutting in or out of circuit at the proper time.

I need hardly say that these are some of the several details essential to their satisfactory working to which I long since gave my attention; and as the question has now been publicly mooted, it may be useful to those of your readers who are interested in this subject to be informed that one of my patents, No. 1644, 2nd April, 1883, deals specifically with these points—anticipating the ideas set forth in Mr. Parker's specification, dated 8th August, 1884, of which a full description is given in your last issue.

Certainty of action, together with the utmost simplicity, are desirable in any devices employed for such purposes; and I venture to think that nothing can be more simple, nor (as I have proved by long experiment) more reliable than the means I have described.

With reference to the space in the cell necessary for any such contrivance, an inch at one end is all that is wanted; and this is, or should be, a normal condition, there being advantages in having ample sufficiency of the electrolyte, as also room for its free circulation.

For the proper working of the arrangement described by me, due precaution must, of course, be taken to ensure equal diffusion of the electrolyte; but this is essential under any and all circumstances, *and must on no account be neglected.* The natural gravitation of the sulphuric acid, as it is discharged from the plates, will quickly cause a difference in density between the top and bottom of the cell of 10, 15, or even 20 degrees, bringing about other evils, such as unequal resistance in the different parts of the cell, and consequent uneven work on the plates. Of the two ready methods for avoiding this, the one to be preferred is the employment of a common India rubber valve hand ball, with a tube of glass or vulcanite attached to it for plunging into the cell, with which the liquor can be quickly "blown up" twice or thrice a week; a work, say, of five minutes for every 20 cells. The other method is to overcharge every other day before stopping for two or three minutes, by which the electrolyte is agitated and to some extent mixed.

I need hardly say, however, that much or continuous overcharging is to be deprecated, not only on account of the waste of energy, but because a minute disintegration of the peroxide plate takes place; the fine mud thus formed and deposited tending, in course of time, to bring about contacts, besides, of course, gradually lessening the amount of active material in the plate. The "blowing" process, which I have always employed, has further the advantage of preventing any accumulation of deposit upon the separating plugs of the plates; a result of much overcharging or of too rapid discharge.

I would observe that by adopting the above-described simple method, I have experienced no difficulty whatever in regulating my accumulators; and having once given my gardener instructions to charge until the acidometer has risen to a certain mark on the scale (in my case 1,220°) I have no further occasion, from month's end to month's end, to give any thought or attention to the matter.

John S. Sellon.

Sydenham Hall, *March 8th*, 1886.

I enclose a copy specification—*vide* lines 7 to 30, folio 3, and 7 to 15, folio 5.

My invention has for its object the effecting the cutting out of or putting into the charging circuit of secondary batteries, commonly called electrical accumulators, by means of the motion imparted to an acidometer, or other equivalent instrument or appliance, such, for instance, as a float or ball, or a vacuum box, which can be made to rise or fall or be actuated in accordance with the variation in strength, density, or specific gravity (during charging or discharging) of the electrolyte or fluid employed in such batteries.

The motion thus imparted to such acidometer, float, or equivalent instrument (which may be suitably constructed either of metal or of glass, or other material with metallic attachments or conductors to cause contacts) actuates mechanical or electrical devices, or a combination of the same, or it may act simply by pressure upon a lever, shunt, valve, or equivalent mechanism, so that the electrical current is shunted off from or on to the cell or cells thus influenced, and by this means each cell to which such arrangement is attached, or each set or sets of cells in connection therewith, which can or may be so controlled thereby, can be cut out of circuit of the charging or main circuit, and can be made to fall in again as required.

For example, one simple arrangement for attaining this end is the employment of a platinum or other suitably-constructed float situated in or on the solution, and making or breaking contact with the rise and fall of the density of the solution. By the rise and fall of the said float or contrivance, as the density of the solution varies, contacts can be made, and by such contacts, through the medium of a relay or other device, sufficient power may be given to work a switch or suitable mechanical or electrical contrivance by which the main charging or the discharging current may be cut in or out as desired.

My invention can be also utilised for the purpose of indicating, by the rise and fall of the acidometer, float, or instrument, the condition of the batteries at any time, that is to say, either the extent to which they have been charged, or the amount of electrical energy remaining in them.

My invention can also be utilised for indicating and registering the amount of current put in or taken out of the cells or batteries, each contact made by the rise and fall of the float or instrument at the time of charging or discharging actuating by mechanism a ratchet wheel, or other suitable device, which sets in motion the necessary mechanism.

It would appear, from remarks lately published on the above subject, that the existence of a practical guide as to the condition of secondary batteries is not generally known.

Now that the working of secondary batteries is beginning to be better understood, the necessity of a reliable indicator and current manipulator is recognised, not only for isolated installations in order to prolong the life of the plates, but also in distributing electrical energy over wide areas.

Having had some experience with an arrangement which depends upon the rise and fall of the specific gravity of the electrolyte, I enclose rough sketches of same, feeling sure it would interest many to know what has been done in this direction.

Figs. 1 and 2 illustrate an indicator; this form I have found very useful for showing the condition and quantity of current put in and taken out of cells.

An acidometer or hydrometer made of platinum or glass is in the electrolyte, attached to this is a wire of glass or platinum, to which is joined a silk thread; this silk thread passes over a grooved wheel, ending with a cup or weight, which is weighted to the desired degree; this arrangement is similar to the action of a wheel barometer.

Under ordinary conditions of working, ten degrees of density may be taken as representing 100 ampère hours, which gives considerable motion to the bath or float. It is obvious that the grooved wheel can be made of such a size as to give large or small readings.

Figs 3 and 4 show an automatic current manipulator or charging switch, whereby any number of sets of cells may be brought in or cut out of the charging circuit by the rise and fall of the density of the electrolyte. . . . .

It will be seen that by such an arrangement sets of accumulators can be readily and surely switched in and out of the charging circuit at any desired point of charge or discharge.

The durability of secondary batteries depends upon this being done at the proper time.

The above arrangements are the invention of Mr. Sellon, patents for which were taken out by him in April, 1883, or nearly three years since.

Henry A. Kent.

[As the drawings 1 and 2 do not appear to us to be necessary to render the explanation of the indicator clear, we omit them; and the remainder of Mr. Kent's letter being entirely devoted to a description of Mr. Sellon's apparatus, to which that gentleman himself refers, we do not think it necessary to re-produce that which can be found by those interested, in specification No. 1,644, 2nd April, 1883.—EDS. ELEC. REV.]

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Telephone Patents.

I note the remarks of your correspondent "Combination," *re* the Valve telephone. His experience appears to have been unfortunate, and he has apparently jumped to the conclusion that the failure to make the New Telephone Company's instruments work satisfactorily, was due to there being no diaphragm in the transmitter. Our experience with the same company's instruments has not been very fortunate, but we put the result down to bad workmanship in the manufacture.

Some months back, the New Telephone Company placed a pair of their complete sets—transmitter, two receivers and call bell—at our disposal for trial.

They were only tried upon a short line, but the articulation was certainly remarkably good, in my opinion far superior to that of the Bell telephone. There was no Punch and Judy talk, nor was there any of the disagreeable jarring or buzzing that one finds with other instruments at times. The one fault appeared to be, a deficiency in the volume of the sound—in the loudness.

Where the instruments broke down in our hands was :—First, we required to work three stations on one line. As every one knows, there is no difficulty with the ordinary arrangement, in working as many as you please ; but with the New Telephone Company's instruments, the whole of the battery being to line, when two stations were speaking, the third was ringing, and causing a continuous clatter in the receivers.

As we were rather busy at the time, we applied to the company to know if they had worked out any plan of overcoming this, to save us the trouble of doing so ourselves, as I have no doubt we could have done with a little thought. In response to this apparently, an inspector was sent down, who appears to have changed the character of the microphone altogether, and we never succeeded in getting the arrangement to speak properly afterwards.

The arrangement which we tried, and which spoke well, consisted—the microphone—of a polished carbon ball, resting lightly on three platinum points, and protected by an inverted footless wineglass. My own opinion is, that the instrument is a good one, but that it requires to be well made, and, perhaps, some small alteration of details, and that its faults are such as time and experience will overcome.

Sydney F. Walker.

In your issue of March 6th, we notice a communication signed "Combination," in which he says he has failed to get the Valve telephone to work. We have pleasure in stating that we bought a complete set of instruments from the New Telephone Company, Limited, having previously run the line. We had the instruments working in one and half hour's time after receiving them, never having seen a pair before, the party we fixed them for being highly satisfied with them. They had previously had a pair of Bell-Blakes from the United Telephone Company.

Anyone requiring a pair fixed in the North of England, we will put them a pair in a week on trial, and if not satisfactory, will take them out free of charge.

Jno. Barrett & Bros.

Yorkshire Street, Burnley.
March 6th, 1886.

Referring to the letter of "Combination" in your issue of 5th inst., allow me to point out that the highly imaginative allegations of your correspondent are best answered by a reference to the testimonials which appear in your advertising columns.

J. W. Barnard, *Secretary.*

New Telephone Company, Limited,
4, Great Winchester Street,
London, E.C. *March 8th*, 1886.

In his letter of February 15th, "Combination" appears to lay the entire blame of the inefficiency of the New Company's instruments on the "Valve" transmitter.

Some of your readers will perhaps remember a controversy that took place in your pages some months ago between Mr. Barnard and myself concerning the membrane receiver of the same company, when I expressed my doubts as to the efficiency of that instrument both on account of the nature of the membrane arrangement and also the wonderful "plug" device employed to assist the magnetising of the electro-magnets, and I cannot now help thinking that the bad results of which "Combination" complains are largely due to the receiving apparatus used.

As regards the "Telephone Conference" proposed by Mr. W. E. Irish, I am unable to discover what possible good such an arrangement could do beyond benefiting the hotel keepers of "London or Paris" and the railway companies leading thereto, as all the telephone conferences in the world cannot alter the patent laws of the country, or, what is, perhaps, more to the point, limit the meaning of that wonderfully flexible and elastic word "diaphragm" as employed in Edison's specification. I notice, however, that one of the objects of the proposed conference is "to investigate claims," and taking these significant words in conjunction with the fact that *a* Mr. W. E. Irish (and I am not aware that there are two telephonic electricians of that name) is the patentee of certain telephones claimed by the inventor as free from the Edison and Bell patents, it is not, perhaps, very difficult to imagine whose claims in particular the conference is to investigate.

In plain language, perhaps Mr. Irish is anxious to float an association to run his patents and imagines that a "conference" would be an inexpensive way of starting the same.

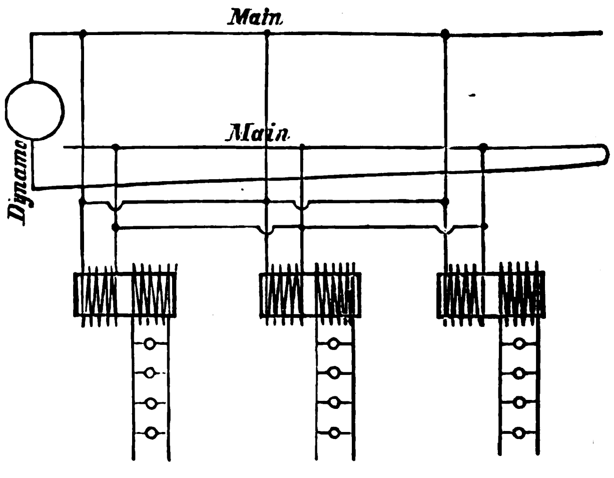
I hope he will contradict me if I am wrong.

"Telephonist."

March 9th, 1886.

The Distribution of Electricity.

In looking over Prof. Forbes's interesting paper, given in your last issue, I note he has omitted an obvious method of arranging the secondary generators parallel, and which, at the same time, allows of a constant pressure being maintained at the lamp terminals. By this method all the points in derivation are electrically equi-distant from the generator, and this being compound-wound for constant E.M.F. no difficulty



ought to be found in maintaining the lamps at a uniform brilliancy. Mains might radiate from the central station, and by means of cross connections, similar to those in the diagram, the danger of any particular district suddenly being left in the dark could be greatly minimised.

I hope to see the matter of distribution by means of secondary generators well ventilated in your columns.

R. C. Jackson.

March 2nd, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 432.

THE ELECTRIC LIGHTING ACT.

THE subject of electric lighting legislation is once again receiving attention, and not unreasonable hopes are entertained that the grievances under which the industry has laboured so long will now be speedily redressed. Nearly a year and a half have passed since Mr. Chamberlain, replying to the urgent representations of Sir Frederick Bramwell and others, expressed himself rather positively against the repeal of the "compulsory purchase clause" in his Electric Lighting Act; and in the interval many changes have taken place. The "ins" have been "out" and now are "in" again; but Mr. Chamberlain is not now President of the Board of Trade, is, indeed, according to a rumour which reaches us as we write, no longer a member of the Ministry. Very little has been done since that date in the shape of public lighting, and the sole blame has been laid, rightly or wrongly, upon Mr. Chamberlain's shoulders. Possibly the period has been sufficiently long to allow of a modification in the views which that gentleman then held; it has not been long enough, however, to cause those who sought the amendment of his Act to shift their ground, for the main point of the Bill which Lord Rayleigh has just brought before the House of Lords is still the repeal of the obnoxious 27th clause of the Act of 1882. The aim of Lord Rayleigh's Bill generally, as will be seen by the "memorandum" in another column, is to place the electric light upon an equal footing with gas as far as legislation is concerned; and, whatever may have been necessary three or four years ago, the time has now certainly arrived when electric lighting enterprise should no longer be subjected to severe restrictions, and should be permitted to treat, free and unfettered, for a share of the public patronage. The committee which has for the last twelve months been working at this matter, framing draft clauses for the Amendment Bill, and endeavouring to influence public opinion in favour of the removal of restrictions, is composed of gentlemen well known in connection with electrical matters; they are not all representative merely of company interests, but are just those who are best qualified to judge of the actual requirements of the case. The fruits of their labour are now before us in Lord Rayleigh's Bill, the most remarkable point in connection with which is that it is almost identical in its provisions with the demands of those who first agitated for a change in the law relating to electric lighting undertakings. One or two interesting points strike us as being worthy of notice. If the Bill becomes law, the maximum dividend which undertakers may pay is 10 per cent. per annum; if a larger dividend is earned, provision is made for a reduction in the price charged for the supply of electricity, but for every farthing per electrical unit taken from the price an additional 5s. per hundred pounds may be paid in dividends. Thus a direct incentive will be afforded for the cheapening of the commodity. If the undertaking still earns more than the dividend payable the surplus must be invested in Government securities as a reserve fund, to be used for the equalisation of dividends and for such special purposes as may be required. There is nothing in the Bill which precludes the purchase of an undertaking by a local authority by agreement; indeed, its framers express their opinion that "reasonable facilities" should be given to local authorities for the acquisition of successful undertakings. Taken altogether, the Bill seems to meet the case very fairly, and we hope to see it pass into law.

But now a word upon another side of the question. We have before asserted that the Electric Lighting Act has been made the scapegoat for much bad work and many failures with which it had no real connection. Whatever may be said by chairmen of electrical companies when accounting to their shareholders for the lack of a dividend, it is an indisputable fact that even now it is impossible to enter upon a central station scheme with the certainty of either practical or financial success. While electrical apparatus have been improved during the last few years to a high state of excellence, there is very much left to be desired when the combined use of these apparatus is attempted for public lighting purposes. The one notable experiment in central station lighting with the aid of secondary batteries in this country has ended in failure, to the justification of our repeated predictions. A great deal has yet to be learnt in regard to the practical development of electric lighting, before it can be entered upon and carried out with the same certainty and precision as gas, and we trust those concerned will not relax their efforts to overcome the difficulties in regard to details which have, so far, prevented successful working. Much as the Electric Lighting Act has been abused, we feel convinced that it has been of incalculable benefit to the few companies which remain in existence, by standing in the way of their hastily embarking upon rash enterprises, which could only have led to disaster. But the time for its usefulness in a repressive capacity has passed, and we hope and expect to see it very shortly modified and extended in such a manner as to encourage genuine enterprise.

Electric Communication in the House of Commons.—Mr. Buxton, last week, asked the hon. member for Staffordshire (north-western division) whether he would consider the advisability of establishing electrical or telephonic signals to the library, reading room, and other parts of the House of Commons, whereby members might be informed of the business under discussion, and of the name of the member addressing the House. Mr. Leveson-Gower said the First Commissioner would take the proposal of the hon. member into consideration. It was one, however, of some magnitude.

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ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XIII.

PREVIOUS calculations show that the power absorbed in the propulsion of an electric car without secondary batteries amounted to 3·99 H.P., whereas the same car, when carrying secondary batteries, requires 4·88 H.P. whilst running under precisely similar conditions.

This difference is by no means serious; but there is about one horse-power and a-half per car lost in the battery, which is the difference between the energy given off by the charging dynamo, and that received by the motor on the vehicle. On the other hand, with the conductor system, where the mean resistance of the leads was taken at ·4 ohm, the maximum running current 47·1 ampères, and the current on the level road 13·82 ampères, we find that the loss through heating the conductors varies when running between 3 H.P. and ·1 H.P. per car; nevertheless, this method of propulsion will, theoretically, prove more economical than the accumulator system, provided that *no artificial resistances* are employed for the purposes of regulating the currents and speeds; but then the motors would have to be perfectly self-governing under widely different loads. If we use no idle resistances with the motor, as assumed in Article IX., and if at one moment four cars were starting and eight running simultaneously, there would be 368 ampères needed for that instant, in which case a temporary heat waste of $368^2 \times \cdot 4 = 54169$ watts, or over 73 H.P. would take place in the conductors.

It is the frequent stopping and starting which reduces the efficiency of the electric tramway with conductors; but as this system will find its application in isolated districts where the bulk of the passengers will travel either the whole distance or to given stations, these disadvantages will not be so serious as they appear at first sight.

The accumulator car, again, will find its development and application in towns, taking its turn with the horse cars, which stop as often as the traffic requires it. The total power consumed will, in spite of extra weight and losses in the conversion of energy, compare most favourably with the conductor system, steam, or any other mechanical power.

If it were merely the cost of power, and the usual well-known items of depreciation in the motive power apparatus, then we could at once draw up a general statement of costs of working our tramline. We know pretty well what a steam horse-power costs, and what the maintenance of dynamos and motors ought to be per annum or per car mile, but the accumulator car contains peculiar parts, whose functions we understand, whose market price we know, but whose depreciation is surrounded with much obscurity; in fact, nobody cares to touch this point, whilst few have the remotest idea of the expenses connected with renewals or repairs of secondary batteries.

Considering that these batteries are made of the cheapest metal, next to iron, one may expect that they are cheap in first cost; it is not the first cost, however, which gives us much concern at present, but the depreciation; and we need not even fix such depreciation at so much per cent. on the prime cost. These accumulators have no other ingredients but lead, their receptacles may be of wood, lined with lead, containing dilute sulphuric acid; the lead plates may, in preference to other substances, be kept apart by India rubber insulation.

Strong wood boxes, protected externally by a coating which preserves the wood from the effects of acid moisture, and internally lined with thin but pure sheet lead, ought to last a long time—several years, at any rate. Three square feet of teak wood, half-an-inch thick, suffice for one tramcar box with lid, including waste. Two square feet of sheet lead, weighing together 4 lbs., serve for the lining The boxes, of course, must be substantially made, with excellent joints; but the cost of making them in quantities can be easily ascertained.

What concerns us most is the renewal of plates. The positive plates deteriorate gradually; the conducting grids get oxidised, brittle, and therefore unserviceable in course of time. This disintegration takes place in proportion to the amount of work that has been done by them. It is the positive plates which require renewing first and most often; but the old plates contain as much lead as the new ones, only they contain some sulphate in addition to oxygen, and the part that originally formed a metallic frame is now a brittle mass. These worn out plates, however, are not valueless; the lead has a recognised market price, and such old plates should return at least from 60 to 70 per cent. of new lead when converted. Including terminals, and waste in manufacture, we require about 14 lbs. of lead (metallic and red lead) for the positive plates of a tramcar cell. These positive plates, when carefully used, should last twelve months; but we prefer to renew them before they are quite worn through, and change them systematically, say, every six months.

Including labour and waste, the 14 lbs. of old plates are really only worth 7 lbs. of new lead; we have thus to spend the money for 7 lbs. of lead every six months for each cell, which, at 1½d. per lb., comes to 10½d. One set of cells for a car would thus take £5 5s. worth of lead per annum; and if we used three sets for each car, the expenses for metal in positive plates will amount to £15 15s. in a year. The labour value in making plates out of lead is not so easily fixed, as it depends upon quantities and facilities of manufacture; this item may be less or more than the cost of material, or it may be the same. With a well organised and first-rate system, turning out large quantities, this cost may be equal to the price of the lead, or £15 15s. per annum per car; bringing the item of renewing positive plates up to £31 10s. a year for a two-horse car, running, say, 90 miles per day, and with 300 working days in the year, this would make an addition of ·28d., or a little over a farthing per mile run.

So far we have only referred to the positive plates, and have said nothing about the negatives. They give little trouble, they do not crumble to pieces with overwork, but they also have faults which reduce their lifetime. It is often said that the spongy lead plates are everlasting, or nearly so; but this is not the case, for they also decay. The grids certainly remain intact; but the paste is turned into white sulphate right through, and the plate finally fails through inertness. But such plates should last at least four times as long as the peroxidised electrodes, and therefore cost less than a quarter of these in maintenance per annum. Adding this to the item previously obtained, we have ·35d. per car mile for renewals of plates. If we allow a liberal amount for repairs on boxes, then the whole cost of accumulator renewals may reach ·5d. per mile. Some persons probably may say that the time is not ripe for estimates based on a large-scale-production of lead plates, but such persons must be reminded that, by allowing three sets of cells per car, we have an unnecessarily large reserve, unless the line is very much more difficult than the one we took for our calculation, and we may dismiss this part of our subject in full confidence of having treated it in a liberal spirit.

Were it not for the extreme lightness and the great activity required of these tramcar accumulator plates, then depreciation account could be rendered considerably less, but prolonged experience tends to dictate definite rules, and we are at last in a position to fix reliable items in estimates, showing the cost of electric locomotion where secondary batteries form part of the propelling apparatus.

Charge and Discharge Regulators. — The letter which we have received from Sir Thomas S. Bazley apparently justifies our queries respecting the Elwell-Parker regulator described in our issue of the 5th inst.

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SECONDARY BATTERIES AS REGULATORS.

WITH reference to the correspondence now being carried on in our columns on the above, we are glad to be able to place before our readers the results obtained from the shunt dynamo machine to which Mr. Littleton refers. These results are as follows :—

Current.	Difference of potential at brushes.
SPEED 900 REVS.	
0 amps.	208·0 volts.
30 „	198·0 „
46 „	192·0 „
64 „	186·0 „
72 „	182·0 „
SPEED 800 REVS.	
0 „	173·0 „
26 „	164·5 „
38 „	170·0 „
50 „	155·0 „
66 „	146·0 „
74 „	140·0 „
SPEED 600 REVS.	
0 „	121·6 „
16 „	117·5 „
28 „	113·2 „
38 „	110·0 „
54 „	101·0 „
62 „	96·5 „

The resistance of the armature is ·119$^{\omega}$ and the field-magnets 58·9$^{\omega}$. It will be observed that the difference of potential falls considerably as the current increases, and this the makers declare to be the proper condition of things required for charging accumulators when the power is supplied by a gas engine or by any prime mover where the delivery of power is in the nature of emphasised intermittent pulsations. We ought to mention that the drop in potential in actual working is somewhat greater than above indicated due to a permanent resistance being placed in the shunt circuit, the dynamo having been built of larger size than was actually necessary for Mr. Littleton's requirements.

From a graphic representation of the relation between the characteristic of the dynamo, the E.M.F. of the cells and the resistance in circuit, it can be shown that with a dynamo in which the curve rapidly descends, the variation in E.M.F. at the terminals of the accumulators for a given variation in speed is much less than with a dynamo in which the curve is straighter and which gives, therefore, a more constant potential. It is also shown that the variation in E.M.F. decreases with a diminished resistance of cells, and finally, if the resistance of the cells and leads is 0, the dynamo can be driven with any variation of speed without affecting in any way the potential at the accumulator terminals.

We wish this question to be discussed on its scientific merits alone, and we must therefore ask those who may favour us with their views on the question to argue close to the matter in hand. Obviously we are not helped to a solution by the statement that "accumulators are by far the most efficient and reliable form of regulator," for admitting this, the object in view is to discover the source of the imperfection which *does* exist, and that they do not act perfectly under all conditions even those most interested must admit if they fairly face the problem.

We do not quite follow Sir David Salomons in his remarks regarding the electrical perfection of dynamos. All good makers construct their machines with the exact conditions of working kept in mind, and the best machine electrically is the one which best fulfils the requirements of the user when working under the conditions for which it has been intended. There is no such thing as electrical perfection *per se.* In this, as in all departments of applied science, the apparatus must be constructed in accordance with the end in view, and perfection is to be gauged by the accuracy with which the adjustment of means to ends is made.

We fear we are among those who would call Sir David to task for stating that a fall in the speed of the dynamo causes a rise of the E.M.F., but we shall be glad to modify our opinion when it is proved to our satisfaction that this is really the case. Meanwhile as neither of our correspondents seem to have satisfactorily answered the question first put, we trust those who can throw further light on the subject will favour us with their views.

THE CHARACTERISTICS OF ALTERNATING CURRENT DYNAMOS.

IN an article which appeared in the ELECTRICAL REVIEW for April 12th, 1884,* some comments were made on the particular forms of characteristic given by separately excited dynamos for generating continuous currents, and it was shown that the curves obtained from these machines exhibited a certain fall of potential due to the weakening effect on the magnets, of the currents flowing round the armature core. Curves were plotted in which ordinates were made to represent the difference of potential at the brushes, and abscissæ the currents flowing in the armature, and from these it was observed that the line connecting the difference of potential with the current had a very different curvature as the magnets were excited to a greater or less degree. When the magnets were saturated the line was approximately straight for a considerable distance, and had only a small inclination towards the horizontal. As the magnets were weakened the inclination increased and the curvature became more decided until, finally, with a still further diminished magnetic intensity the line curved over rapidly at a greater inclination. A formula which approximately expressed the difference of potential at the brushes when the magnets were strongly excited was given of the form

$$V = E_1 - C\,(q + r + p)$$

where V is the difference of potential at the brushes; E_1 the E.M.F. when running on open circuit; C, the current flowing through the armature; q, a term which measures the weakening effect of the armature on the fields; r, the resistance of the armature; and p, the spurious resistance due to self-induction. If the formula is to be true, q must be very small, and this is the case only when the magnetic effect due to the magnets is very large compared with that due to the armature. Under these circumstances q may be neglected altogether, the formula becoming simply

$$V = E_1 - C\,(r + p).$$

When q becomes appreciable it can scarcely be called a constant, but is rather a coefficient, which has a different value for every different value of the current.

The analogy between the curves from separately excited continuous current and alternating current machines is a close one, and it will be seen from fig. 1 that under different degrees of magnet excitation the curves obtained from the latter have very different shapes.

In a note from the pen of M. Felix Lucas, published in the REVIEW under date before referred to, a formula for the E.M.F. of alternating current machines is given of the form

$$(R + r + p)\,I = \phi$$

* The E.M.F. of Dynamo Machines excited by a Constant Current.

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whence we get

$$\text{R I} = \phi - \text{I}\,(r + p)$$

where ϕ is the E.M.F., I the current, R and r the resistances of the external part of the circuit and the armature respectively, and p a fictitious resistance due to self-induction. The latter formula is identical with the formula given for the difference of potential at the brushes of separately excited continuous current machines, but in experimenting with alternating machines I have not found the relation between the difference of potential and the current to be of the simple character here given unless the field magnets are very strongly excited and the convolutions on the armature few in number. This was the case with continuous currents. When the field was strong the characteristic was practically straight, but as the field was weakened the characteristic drooped with a curvature increasing as the magnetism decreased. M. Lucas assumes that ϕ is constant for all values of the current, but as a matter of fact this is not the case, since the strength of the fields is reduced by the increased current in the armature. The weakening effect becomes of importance, especially when the fields are weakly excited, and this is fully shown by the curves here drawn which were obtained from a W_2 Siemens alternating current machine driven at a constant speed of 650 revolutions per minute. The current in ampères represented by abscissæ was measured by a Siemens dynamometer, and the ordinates show differences of potential at the brushes as measured by a Cardew voltmeter. The machine had on its armature 12 coils, each having 208 convolutions of wire. The coils were for the test coupled in six parallels of two in series and had a resistance of ·112 ohm. There were 12 magnets on each side of the armature having cores $2\frac{1}{16}$ inches diameter with 185 turns of wire on each. Distance between the magnet faces about $2\frac{1}{4}$ inches. The magnets were coupled in series, and when thus coupled they are in usual working excited with a current of 21 ampères, the machine then yielding about 75 ampères. The following are the results obtained:—

SIEMENS W_2 MACHINE.—Speed 650 Revs.

TABLE I.

Magnets excited with 24 ampères.

Current.	Difference of potential at brushes.
0 amps.	125·00 volts.
20·65 „	123·32 „
26·67 „	120·00 „
29·21 „	121·00 „ (?)
33·74 „	118·92 „
39·00 „	117·00 „
43·00 „	116·00 „
50·60 „	111·13 „
54·67 „	110·20 „
63·11 „	108·82 „
68·52 „	106·46 „
71·57 „	102·87 „
73·53 „	100·47 „

TABLE II.

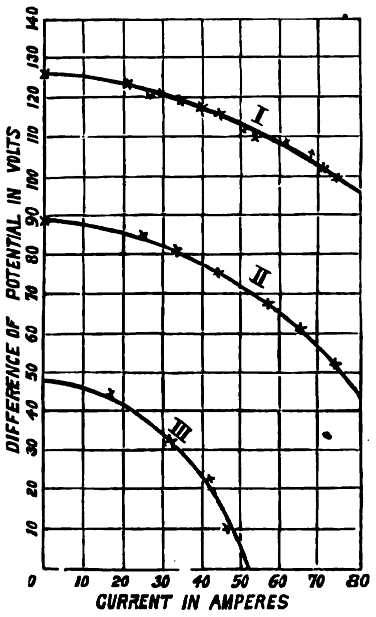
Magnets excited with 12 ampères.

Current.	Difference of potential at brushes.
0 amps.	89·00 volts.
16·87 „	86·55 „
23·85 „	85·24 „
33·74 „	81·31 „
41·63 „	75·81 „
58·43 „	68·43 „
65·33 „	61·00 „
72·56 „	52·00 „
80·00 „	45·00 „

TABLE III.

Magnets excited with 6 ampères.

Current.	Difference of potential at brushes.
0 amps.	47·00 volts.
16·87 „	43·75 „
23·85 „	39·5 „
33·74 „	32·00 „
41·32 „	23·13 „
47·71 „	10·00 „
51·30 „	0 (short circuit)



Curves I., II. and III. corresponding to the three different sets of readings have been plotted from these results, and it will be observed that the curvature becomes excessive where the magnets are weak, as in III., the line here cutting the axis of abscissæ at 51·30 ampères. A greater current than this with the same speed and exciting current is impossible, and this explains why alternating current machines can be in some cases short circuited with impunity.

I have not been able to try the effect of introducing into the armature coils iron cores, but it may be safely inferred that if other conditions remain the same the E.M.F. will fall more rapidly with than without these cores, although the initial E.M.F. will be greater. It is also probable that the curve may be of a different character, the E.M.F., for example, decreasing rapidly at the beginning of the curve, then more slowly and finally with rapidity. This is mere surmise, and it would be well if some experimenter, with time at his disposal, would undertake the experiment indicated for the benefit of his less fortunate brethren.

W. B. ESSON.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

II.—SHUNT MACHINES.

LET it be required to wind the magnets so as to make a shunt machine.

It is evident that the armature has to supply the sum of the currents in the external circuit and in the shunt magnets. It is therefore necessary to determine about what this shunt circuit current should be. In large machines it may be taken at about 1·5 to 2·5 per cent. of the current in the external circuit, and in small machines for from 10 to 20 incandescent lamps, it will have to be taken as high as 10 per cent., and even

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higher, in order not to make the cost of the wire too great. Having determined this, approximately only, the machine is run as above described until it gives the required current for the lamps plus that which will be required by the shunt. Let (a W) represent the magnetism in ampère windings obtained in the test under these conditions.

It is evident that the size of the wire to be used for the magnets depends upon various quantities and conditions. For instance, it must not be too small, so that the current does not heat it too much. It must be large enough, so that the total resistance of the coils is not so great that it will not take its proper current as shunt to the machine. It must not be so large, that it takes up more space than is allowed for the coils. It must not be so small, that after heating, its resistance becomes too high to take its proper current. It must be so large that its resistance is small enough to enable an adjustable resistance to be placed in series with it, and to regulate the machine for varying service. Therefore, in trying to calculate the proper diameter directly from the ampère windings, by trying different values for the current and corresponding number of ampère windings and calculating the resistance and size of the coils for each case, to see which wire is correct, it may be found to be a tedious process and one which may or may not be of considerable length.

In order to take into consideration all these factors, the writer has deduced the following formulæ, which may be used to determine, by a single calculation and with certainty, what diameter will meet these conditions, thereby facilitating calculations very much, as it eliminates the element of guessing.

Let (a W) represent the ampère windings obtained from the above experiment.

a = current in the shunt magnets of the finished machine.

W = total number of windings or turns on all the magnets of the finished machine.

R = total resistance of the magnet coils of the finished machine, in legal ohms.

V = potential at the poles of the finished machine.

d = diameter of the naked wire in mils.

l_m = mean length, in inches, of one winding.

l = length, in inches, of one winding of the lowest layer, which is about the same as the periphery of the core.

Then it is evident that the resistance is proportional to the total length, W l_m, and inversely as the square of the diameter, and is equal to

$$R = 50{\cdot}13 \frac{W\, l_m}{d^2}\, \theta$$

in which θ is the specific resistance, that is, the resistance in legal ohms of 1 metre of copper wire of 1 square millimetre cross section, at 0° C., while the constant 50·13 contains all the various reduction constants.

But by Ohm's law

$$R = \frac{V}{a}.$$

Therefore

$$\frac{V}{a} = 50{\cdot}13 \frac{W\, l_m\, \theta}{d^2}$$

From which

$$d = \sqrt{50{\cdot}13 \frac{(a\, W)\, l_m\, \theta}{V}}$$

From which it is evident that the diameter can be calculated directly from the (a W) and the potential, if the mean length of one winding is known.

The value of this mean length can be determined from the inside length, l, if the thickness of the coil is known. But this thickness again depends on the number of ampère windings, the resistance of the wire, and the thickness of the insulation. It is possible to determine relations between all these and introduce them into this formula, thereby eliminating the unknown factor l_m, but the writer has found it to make the formula so complicated that it becomes practically too troublesome to use.

In actual practice so many elements enter, which are either inexact or limited to certain values, that an exact calculation has little value. For instance, the copper may have, and probably has, a different specific resistance than any figure which one might assume. Again, an almost inappreciable diminution or increase of the diameter changes the resistance materially; so also the temperature to which it is raised. The sizes of wire are also limited to certain fixed numbers, and the insulation has not always the same thickness. For these reasons, therefore, the following approximate method of using this formula will be found to be practically safe and correct, while it is at the same time much more simple.

The thickness of the coil is practically limited; if it is too thin, there is more iron in the core than is necessary, or the magnets are too long, or both; if too thick, the magnets are probably over saturated or too short, or both. Some of the older authorities say that the thickness of the coil and core can be made equal. In the writer's experience, however, it was found that this is far too thick for machine magnets, as it makes the cost of both wire and energy much greater than it ought to be. A better figure, obtained by the writer from actual practice, is, for a flat oval magnet, a maximum limit of about one-third the thickness of the core for cast iron, or about one-half the diameter of the core if it is circular. This will be found to be more nearly correct in actual practice for machine magnets, as it is based on real results as distinguished from theoretical deductions.

The thickness being, therefore, limited to a comparatively small range, it is quite safe to calculate the mean length of a winding from some assumed thickness of coil, for it will be found that this length will vary very little for any possible variation in the thickness. For instance, in an actual case of an oval magnet, diminishing the thickness of the coil as much as 50 per cent. decreased the mean length only 7 per cent.

Assuming, therefore, a certain approximate thickness of coil and having given the periphery of the core, the mean length may readily be calculated as follows. For an oval magnet, not too flat, the lengths of the inside and outside layers are in the proportion:

$$\frac{a + b}{a + b + 4\,c}$$

in which a and b are the length and breadth of the oval cross section of the core, and c the assumed thickness of the coil.

This gives for the mean length of a winding

$$l_m = l + \frac{2\,c\,l}{a + b}$$

l being the periphery of the core in inches. For a circular magnet in which the core has a diameter D the mean length is, evidently,

$$l_m = \pi\,(D + c).$$

If it is found, after completing the experiments and calculations, that the assumed thickness of the coil is much too small, then it is preferable to lengthen the magnet cores so as to reduce this thickness of coil, provided the magnet cores are not already saturated, that is, the cross section of the core is not too small.

On the other hand, if it is found that the necessary thickness of coil is much smaller than the assumed, it shows that the magnets are too long.

Having now determined this mean length for an assumed thickness of coil, the diameter of the wire can be calculated directly from the formula:

$$d = \sqrt{50{\cdot}13 \frac{(a\, W)\, l_m\, \theta}{V}}$$

without having first to determine what current and what number of windings to take, as the known quantity (a W) enters directly into the formula.

From what has been said above, some allowance, or factor of safety, must be taken for the resistance, in

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order that when the wire is wrapped, it is not found that the resistance is a little too high to take its proper current. An allowance should also be made for introducing an adjustable resistance by which the machine may be regulated. The factor of self-induction may also enter, and will have the effect of apparently increasing the resistance, depending upon the degree of pulsation of the current, or, what is the same thing, on the number of commutator strips. In order to make allowances for all these factors, and introduce them into the formula, it is only necessary to diminish the value of the potential, V, in the formula accordingly. For ordinary purposes, 10 to 15 per cent. may be allowed, but it is safer to take 20 per cent., and even 25 per cent., if considerable variation in the adjustable resistance is to be allowed for. Assuming 20 per cent., it is only necessary to multiply the potential, V, by 80, and introduce this factor directly into the formula.

Assuming for ordinary good copper wire a specific resistance θ equal to 0·0162 at 0° C., the formula becomes, assuming a temperature of about 70° Fahr.,

$$d = \sqrt{\cdot 875 \frac{(a\ \mathrm{W})\ l_m}{\mathrm{V}}}$$

in which d is in mils. and l_m in inches.

If this should give a value which is too small, so as to be impractical, it shows either that the length, l_m, is too small, that is, the cross section of the magnet too small, or that the ampère windings are very small, or that the potential is high for the required ampère windings. In the last two cases it is only necessary to take a larger diameter of wire and add external resistance in the shunt circuit.

If the formula should give a very large diameter, it shows that either the magnets or the ampère windings are too large, or that the potential is very small for the required ampère windings. If the magnets are already saturated, and therefore cannot be made smaller, then it shows that the machine is overworked, unless it happens to be a low potential and high current machine, such as a plating machine, in which case a large value for d is quite correct.

Having determined d, it is evident that if we could now assume any current, a, and make the corresponding number of ampère windings $\frac{(a\ \mathrm{W})}{a}$, in all cases we would obtain the proper ampère windings and the proper resistance. But there are practical limits, which are quite narrow in most cases, for we have assumed a certain mean length, l_m, or a thickness, c, of the coil, and we must limit ourselves to this value of l_m to a certain extent at least, in order that the resistance may not differ much from what we must have. The method to pursue, therefore, is as follows: assume a certain current, a, for a large machine about 1·5 to 2·5 per cent., and for a small machine as high as 10 per cent. of the total current, and by dividing it into the ampère windings, to obtain the number of turns, calculate the space occupied by the coil (remembering to use the outside diameter of the insulated wire), and see how near the thickness corresponds to the assumed thickness, c. If it turns out to be much thicker, it shows that the machine is overworked, and you have to take a larger current in order to diminish the number of windings. If, on the other hand, it gives too small a thickness of coil, it shows that the machine could be run more economically if necessary, and a smaller current could be used at the expense of an increased cost of the wire. It would not require more than a few trials to determine the right number of turns.

If it is found that with the proper assumed current and the corresponding windings, it makes this thickness of coil too great, it shows that the magnet cores are too short, provided they are not already saturated. Or if, on the other hand, the thickness of the coil is found to be much thinner than the assumed, it shows that the magnets may advantageously be shortened, provided they are not already saturated.

ELECTRIC LIGHT AT THE PRINCE'S THEATRE.

By ERNEST L. BERRY.

THIS installation has now completed its second year of running without a break down or any mishap in the lighting. The plant consists of a 12 H.P. Clarke's gas engine, manufactured by L. Sterne and Co., a Siemens $L.D_1$. dynamo, and storage cells by the Electrical Power Storage Co. The Swan lamps require 108 volts E.M.F., and are of 16 C.P.

For further particulars of the installation refer to ELECTRICAL REVIEW of April 11th, 1885.

The engine has during the year run for 2,559 hours, and has not given the slightest trouble either in starting or when at work. It was overhauled in December last, and the water jacket cleared of its deposit of lime. The only renewals we have had for the engine have been a few piston rings.

Besides doing its ordinary work of driving the dynamo, it is used frequently for pumping water into the tanks to supply the hydraulic fire proof curtain and lift. In regard to the E.P.S. cells, as a difficulty was experienced in the leaking of the teak boxes, it was decided, while making a change, to put in some of the new cells containing all the latest improvements and supplied in glass boxes, and of these new cells, although put to very severe tests, not one has failed.

We have repacked several of the teak boxes with new positive plates and lead connections, and these have answered admirably. We had, up to 16th January of this year, one cell of the old type, which has been in constant work for two years, and has not on any occasion failed; it has not been repaired or seen to in any way. It is evident, therefore, that there is no reason why, when carefully made, the accumulators should not last throughout this length of time without being in any way renewed, and it is expected that this result will be obtained with the later cells put down. The dynamo has run very well; a new commutator was put on in December last, the old one during its run having been turned up three times, and 10 pairs of brushes have been used during the twelve months. The lamps show a somewhat better average than last year, on account of our being able to get 30 of the broken looped ones repaired. We have renewed during the year 78 lamps from the following causes:—38 by carbons, 10 by accident, and 30 by loops breaking off; the cause of so many loops being broken off is through using 18 lamps to light up a scene of the "Great Pink Pearl" for six months, the constant moving about breaking the loops, and occasionally one got broken by a fall. There are several lamps that were originally put up still burning, having run for 2,500 hours. Subjoined is an abbreviated account of the working expenses, and also the repairs and renewals for the year.

Working Expenses.

	£	s.	d.
Electrician and assistant ...	239	5	6
Gas	188	4	0
Lamps	14	5	0
Oil for engine, shafting, dynamo and pump	10	0	0
Waste	1	12	6
Ten pairs brushes	2	10	0
Lamp shades	0	15	0
Sundries, &c.	4	0	0
	£460	12	0

Repairs and Renewals.

	£	s.	d.
Dynamo	12	9	0
Engine	7	0	0
Accumulators	187	9	6
Belts	11	5	4
	£218	3	10

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	£	s.	d.
Total for working	460	12	0
„ repairs	218	3	10
	678	15	10
„ previous year	452	10	0
	£1,131	5	10

grand total for two years' working.

The increase in the second year's expenses are entirely due to extra performances.

Subjoined is Mr. Bruce's certificate as to the working of the installation :—

"I have great pleasure in again certifying to the successful working of the electric lighting at the Prince's Theatre. It has been in operation for more than two years, and during the whole of that period it has not failed on any one occasion. I am also greatly pleased at its adaptability for stage purposes ; the lighting of the stage during one act of the 'Great Pink Pearl' was most successful and original, and I hope before long to still further try its uses for stage effects.

"EDGAR BRUCE.

"The Prince's Theatre,
"*March* 11*th*, 1886."

THE ELECTRIC TRAMWAY AT RYDE.

THE formal opening of the new electric tramway which has been laid on Ryde Pier by the firm of Messrs. Siemens Brothers, a description of which has already appeared in the ELECTRICAL REVIEW, took place last week in the presence of the South-West of England District Association of Gas Managers, who this year held their annual dinner at Ryde. The working of the electric tramway was explained by Mr. A. Siemens to the visitors, who numbered about 70. The latter were then conveyed in two parties up and down the pier, two cars being used, and the smooth and rapid motion gave the highest satisfaction. The President of the Association afterwards gave a banquet at the Pier Hotel. In the course of the *post prandial* proceedings he proposed the health of Mr. Siemens in terms of a highly eulogistic character. Mr. Siemens, he said, was the representative of a noble scientific family, and his reputation was world wide. He had done great things with electricity as applied to railways in Paris, Ireland, and on different parts of the Continent, and now, for the first time, England had an opportunity of seeing what might be done for locomotive travelling by means of electricity.

Mr. Siemens, in responding, remarked that that day they were in some respect celebrating the triumph of the application of electricity as a means of propulsion. Every scientific discovery or development of knowledge was for the general good ; and just as gas had not extinguished our lamps, or the steam locomotive horse traction, just as little would the electric light extinguish gas. The family to which he had the honour to belong had studied for the purpose of developing all branches of science and useful invention. Metallurgy, glass making, gas making had been some of the subjects to which they had devoted attention, and now electricity. The general progress of the race was what they all ought to aim at.

Alderman Cudlipp, in introducing "Prosperity to the town of Ryde" remarked that he believed it would mark a new era not only for the Ryde Pier Company but also for the inhabitants of the town and the Isle of Wight generally.

Apparatus for High Electromotive Force.—The Board of Examiners of the Franklin Institute give a report in this month's journal of the society on "Apparatus for high electromotive force." This will be found of much interest to electrical instrument makers.

THE EFFICIENCY OF DYNAMOS.

DR. HOPKINSON writes that in Mr. Gisbert Kapp's article, which we reproduced from a recent issue of the *Engineer*, on the experiments to determine the efficiency of the Edison-Hopkinson dynamo recently undertaken by Messrs. Mather and Platt, there is an error in the data which is important, as it materially affects the results deduced from the figures. Dr. Hopkinson says : Mr. Kapp has assumed that the zero of the dynamometer scale employed was the point at which the index would stand when the machine was at rest. Such, however, was not the case, as the scale was placed arbitrarily, and all the experiments made by taking the difference of two readings—the one when the machines were working with a known load and at a known speed, and the other when the machines were running at the same speed without load and with the magnets unexcited. The dynamometer readings, therefore, in the three sets of experiments quoted by Mr. Kapp were 29, 27·5, and 23 respectively, and the efficiency in the case selected by Mr. Kapp for discussion is—efficiency of generator, 93·23 ; efficiency of motor, 93·37 ; of the double conversion, 87·05.

It is true, as Mr. Kapp points out, that this does not include the friction of the bearings and of bending the belt round the driving pulley. This was intentionally excluded as being essentially a variable quantity depending on lubrication and the kind of belt employed, but at the same time it was determined accurately for the two machines in question by the following device :—The dynamos were run at their proper speed without load, and the dynamometer reading noted, the driving engine was then reversed, and the dynamometer again read ; clearly the difference in readings is twice the friction of the two machines plus twice the work done in bending the belt. By this method these losses for one machine were found to amount to 628 watts = 0·84 horse-power when running at 800 revolutions. This is materially different from Mr. Kapp's calculation of 5·18 horse-power for the two machines.

Again, Mr. Kapp desires to take into account also the variation in the friction, if the belt were transmitting the full power required to drive one dynamo. Here, again, in any comparative results, this would be better omitted, as it depends entirely on the angle which the belt makes with the horizontal, and under certain circumstances the friction might be actually less when the larger power was being transmitted. Following, however, Mr. Kapp's suggestion that the mean of the results with and without friction should be taken, there is a loss of 314 watts not taken account of in Messrs. Mather and Platt's figures, amounting to 0·73 per cent. Hence the commercial efficiency of the generator is 92·5 per cent., and of the motor 92·6 per cent., as against 91·5 per cent. and 88·5 per cent., the figures calculated by Mr. Kapp.

It would, perhaps, have been unnecessary to have entered into the above discussion in regard to a difference so small, but in the case of dynamos so perfect as converters of energy that the total loss is under 8 per cent., a matter of 1 per cent. is no small proportion of the whole waste.

REVIEWS.

Formulaire Pratique de L'Electricien. Par E. HOSPITALIER. Quatrième Année, 1886. Paris : G. Masson, Editeur, 120, Boulevard, St. Germain.

In issuing the new edition of his well-known work, M. Hospitalier has made numerous corrections and changes such as practical experience has suggested. He has not hesitated to substitute correct terms for erroneous ones, in cases where the latter, through long continued use, have become almost established. The whole of the phenomena of induction have been con-

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sidered as due to variations in the flow of magnetic force surrounded by a circuit. The chapter on "Measurement" has been made more complete by the addition of the methods of measurement of periodic currents, either alternating or direct, and descriptions are given of new forms of galvanometers, wattmeters, &c. Statistics are also furnished relative to new batteries, thermo-piles, accumulators, incandescence lamps, motors, &c. Reference is made, moreover, to "transformers." Altogether, the new edition is a marked advance on the old, and has greatly improved the original work, excellent as the latter was.

Precautions to be Adopted on Introducing the Electric Light, with Notes on the Prevention of Fire Risks. By KILLINGWORTH HEDGES. London: E. & F. N. Spon, 125, Strand.

There is much in this small work that is commendable, and if it were not that it to too great an extent partakes of the nature of an advertising catalogue, it would be deserving of a more highly favourable notice than can under the conditions be given it. The rules and directions for running wires for selecting the sizes of the latter, for fixing "cut-outs," &c., are very plainly put. An example of a Specification for Electric Light Work is also most useful. The few formulæ and tables which are given are, we consider, judiciously selected.

THE AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE RELATIONS OF ELECTRIC LIGHT COMPANIES TO INSURANCE.

By Mr. C. J. H. WOODBURY.

ONE of the elements naturally disregarded at the outset in the rush to invent, make, and install the apparatus, was the possibility that electricity might, like other methods of lighting, become a cause of fire.

Soon numerous fires served as a reminder that electricity as applied at that time, possessed no immunity from consequences similar to those resulting from other methods of illumination, and public opinion for a time had a tendency to veer to an extreme position; even farther from the truth than its first assumption that electricity could not produce a fire.

A careful examination of the circumstances attending a number of these fires, and a repetition of these conditions upon electric lighting plants, served as the basis of the regulations for the use of electric lighting apparatus, prepared by the writer for the Factory Mutual Insurance Companies, a little more than four years ago. It would have been impossible for the work to have been carried on had I not received the most cordial co-operation from the electric light companies; and the electricians at the head of these companies freely gave of their experience, in the endeavour to determine the facts at issue.

The results of this work warranted the opinion that a well-arranged electric lighting plant was the safest method of illumination, and the experience of time has sustained that position.

The essentials for safety in an electric lighting plant are few and simple. In the presence of combustible material, arc lights should be enclosed in globes resting on closed stands with a raised edge, confining the sparks and copper, and some extra stop at the bottom of the lamp to prevent the lower carbon from falling in any contingency. The feeding apparatus at the lamp should prevent the formation of an undue arc in case of any disarrangement. Switches should be constructed so that an arc could not be formed by their use. The electricity must be confined to its metallic circuits, and the conditions of its use controlled.

The regulations found necessary to specify these particulars in detail are of some length, but do not embody any other features. Experience has shown that they have served the purpose for which they were intended, for I do not know of any fire from electric lighting apparatus except where they have been violated.

The chief elements of danger are conductors of high resistance, generally formed by two earth contacts, and sometimes by a conductor between two wires of different potential. Such diversions of current are generally caused by water penetrating the insulation, and it is of importance that the insulation be waterproof, wherever there is liability of exposure to moisture.

Careful attention should be given to the importance of daily tests for ground connections; and for this purpose an ordinary bell magneto is the most convenient apparatus. The electric bells and small galvanometers with low resistance coils frequently used for this purpose, are not sufficiently delicate, as they cannot indicate a weakness in the insulation, unless its resistance be less than ten to one hundred ohms, according to circumstances.

The value of this method of inspection which I have described is shown by the results following its adoption. In the autumn of 1881 and winter of 1882, 23 fires were caused by 61 electric lighting plants in mills insured by the Factory Mutual Insurance Companies in the eastern portion of the United States. The apparatus was inspected and the alterations necessary for safety specified and carried into effect, and there has not been a single fire from electric lighting apparatus on this property since that time, although the number of mills using electric light has increased to nearly 200, and the average size of the plants greatly enlarged. From being a legitimate cause of apprehension on the part of the underwriters, the hazard of electric lighting, in this field at least, has subsided into a matter of routine inspection.

There is a prospect of new matter at issue, which will tend to reverse the present conditions relative to safety in connection with the distribution of electric lighting. There is a widespread feeling of opposition to aerial electric wires, and several city governments with the intrepidity of practical politicians have passed ordinances decreeing that the wires must be buried.

It is well known that the use of all underground electrical conductors is attended with special difficulties.

The few instances where wires over buildings interfered with ladders of the fire department might have been avoidable by the further elevation of the wires, or by their crossing the streets at nearly right angles. In the natural course of improvement the lines in cities are being changed from their scattered courses and systematised upon permanent fixtures high enough to carry the wires a reasonable distance above all roofs. Aerial wires certainly furnish the most ready means for electric companies to reach their customers, who are frequently distributed very unevenly over a city, and, like all other seekers after trade, may at times conflict with other interests.

The network of wires over cities serves as the most efficient protection against lightning—these conductors, by their great number, scattering the force of thunderbolts and conducting them to earth; on this account thunderstorms are much more destructive in the country than in cities.

As for personal danger, a lineman is in infinitely greater danger from gravity than from electricity.

I repeat that most of the fires from arc lighting systems have resulted in the diversion of the current by two contacts, one of them being a ground which had existed for an unknown time and the second being an accidental ground, generally of increasing resistance, until it converted the electricity into heat whose temperature was high enough to ignite combustible material. When a ground exists anywhere on a circuit, this ground is trying to form a second connection at the weakest point in the insulation anywhere on the whole circuit, irrespective of position. The one connection to earth may exist near the dynamo and the other in some building at the extreme portion of the circuit, or it may be only a few inches away.

Many underground arc lighting circuits have received faithful trials without obtaining satisfactory results which would warrant their adoption by any form of American practice.

In Philadelphia, the escapes from an underground system of electric arc light wires on Chestnut Street are believed to have been the cause of several severe explosions of illuminating gas leaking through the ground. On Delaware Avenue, in the same city, an underground circuit with different insulation received a careful trial, until the escapes through defective insulation, in spite of numerous repairs, diverted so much of the electricity from the circuit that the lights could not be maintained and aerial wires were substituted. The temperature of these escapes was so great that the sand was partially fused in places, and if the lights had been inside of buildings there would have been a liability of such points of excessive heat occurring in the presence of combustible material with destructive consequences.

The result of a few weeks' experience with a short underground circuit is no measure of its capacity to fulfil the requirements necessary for central station arc lighting, as it requires time to develop the faults in such conductors.

In conclusion, it may be said:—

1. That the present application of electricity forms a relatively safe method of lighting.

2. Underground wires connecting lighting currents contain elements of serious danger in proportion to their defects of insulation.

3. The compulsory burial of all electric wires would be oppressive to the electric interests.

Our methods of life are so closely interwoven with the uses of electricity that we are dependent upon its applications, especially to transmission of speech, telegraphy and illumination, and any interference with the legitimate exercise of those interests will not be measured by the impaired value of plant or load of excessive expenditures, but will be a detriment to each member of the community now benefited by its use.

Mr. W. S. WILKINSON and Gen. JAMES M. ANDERSON, underwriters, of Baltimore, expressed their satisfaction with what Mr. Woodbury had said on the subject of safety. Gen. Anderson said that as far as the Baltimore underwriters are concerned they are completely in the hands of the electric light men so far as such lights are concerned, since there is no official inspection made there as in other cities. There had been comparatively few fires there from electricity, and he regarded it as quite as safe, if not safer, than gas lights. The electric light was used on the Bay Line steamers, and it had given more satisfaction than gas.

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Mr. GILBERT then called the attention of the Association to the circular recently issued by himself and Mr. English advocating the formation of a mutual fire insurance company among electric lighting companies so as to secure much lower rates of insurance. He said that returns already in from 31 cities or plants showed a total of property liable to destruction in case of fire of $1,171,000, covered by $481,000 insurance, the premiums paid averaging from ¾ per cent. up to 4 per cent., with a total of premium paid for three years of $119,112 on a total loss amounting to about $1,000; that was seven-tenths of a mill on the amount insured. Yet the property was often rated as extra hazardous. He believed there would be in the United States now to insure about $5,000,000, and in five years' time the amount would be trebled. Another argument he presented was that it would help sub companies to secure repairs from parent companies at a price nearer the actual cost, or else would help them "fit up a hospital for their own work."

Mr. CLEVELAND supported the movement warmly, as highly proper and desirable, and offered a resolution endorsing the plan in the name of the association.

Mr. MORRISON objected very strenuously to any action of the kind.

Mr. LINNELL instanced Richmond where his company was refused insurance by six companies, and to-day they were insured at the high rate of 1¼ per cent. He was in favour of the plan proposed.

Mr. WOODBURY described the well-known and favourable experience of the New England manufacturers' mutuals, but it seemed to him that the functions of the meeting were merely advisory, perhaps commendatory in such a matter. Whatever was done must be done by the individual action of some of them.

Mr. RENSHAW complained of the difficulty in getting reasonable insurance on their station in Washington, and approved the scheme of organisation.

Mr. KING was in favour. They were paying 1¾ per cent. in Minneapolis, and would like to reduce it if possible.

Mr. GILBERT said that the average rate of the 31 reports was 1·65 per cent. He held that the lowering of the rate of insurance meant that they would be able to furnish light cheaper.

Mr. WEEKS said that they had paid 3·10 in Kansas City, but as it was not a living rate, had kicked and got it down to 1·45.

After further discussion, the following was agreed to:—

Resolved, "That this association indorse the plan of an organisation of a mutual electric light insurance company."

LECTURE—ELECTRIC LOCOMOTION.

A LECTURE on Electric Locomotion was given by Mr. A. Reckenzaun on the 10th inst., before the East of London Association of Marine Engineers and Foremen, during an ordinary meeting at the Poplar Town Hall.

Assisted by working models and numerous diagrams, the lecturer explained in his usual clear and lucid manner the principles involved in the production and transmission of electric currents.

After referring to numerous successful electric railways in this and other countries, and describing the various methods of conveying the energy, special reference was made to the mechanical details of construction, and Mr. Reckenzaun dwelt at length upon the necessity for all mechanical engineers to get a thorough knowledge of electrical science; for, he said, electrical engineering was rapidly becoming an important branch of mechanical engineering, and it was in the judicious combination of the experiences of both that electricity has made such rapid advances, and that it will continue to advance. Mechanical engineers are apt to look upon electric locomotion as an expensive amusement; they are apt to declaim against the process of converting steam power into electric energy, and then to transform this energy again into mechanical power, thereby wasting a large percentage of the available force in the course of this double, and often treble, conversion.

Mr. Reckenzaun went to the root of this matter, commencing with the efficiency of the dynamo; tracing the possible losses in conductors, motors, and gearing of an electric tramcar, he showed conclusively that in many instances it is far more economical to convert steam into electricity and use it for propulsion, than to apply steam direct on the locomotive. The doing away with a separate locomotive, which for obvious reasons must be at least as heavy as the vehicle behind it, does in itself offer advantages which more than counterbalance the waste of energy referred to. By placing the electric motor under the vehicle carrying the passengers, we utilise the dead weight of the former and the live weight of the latter, to produce the desired adhesion between the wheels and the rails; this, in the case of a car whose motor receives its energy from conductors, the motive power apparatus need not weigh above half a ton, or taking the system of accumulators, with its extra ton of cells, we see the gain over a steam locomotive, or any other locomotive, weighing from 6 to 10 tons. Considering that the tractive force must be proportional to the load to be moved, it is evident that with so great a saving in dead weight we can easily afford to lose a large portion of the energy in transmission and conversion.

No one would put a separate locomotive upon a tramline, if he could place the motor under the car. There are exceptional cases where a system of haulage is advantageous, such as the system of telpherage, the transport of goods along overhead rods carried on posts; but even the telpher locomotive must be provided with special appliances for obtaining a good grip upon the rods in lieu of rails. Another case is that of underground haulage in mines, where a number of small trucks have to be pulled along, and where it would be inconvenient to provide a motor for each truck in a train: but it is a strong point in favour of electric tramways that the motor can be made to form part of the vehicle carrying the passengers.

The construction of electric boats formed the concluding part of Mr. Reckenzaun's instructive lecture, which was listened to with marked attention and warm approval.

The President of the Association, Mr. George Williamson, moved a hearty vote of thanks to the lecturer, which was most cordially given.

MEMORANDUM UPON THE ELECTRIC LIGHTING ACT (1882) AMENDMENT BILL.

Presented by LORD RAYLEIGH *in the House of Lords.*

THE main object of this Bill is to amend the Electric Lighting Act, 1882, so as to place electric lighting undertakings in the same position as gas undertakings, both as regards privileges and obligations.

The chief provisions are—

1. That where electricity is not ascertained by meter, the consumer shall not use any lamp other than such as has been provided or approved of by the undertakers, or any lamp calculated to expend more electricity than he has contracted to pay for. This is done by clauses 3—6 of the Bill, which, in effect, re-enact (*mutatis mutandis*) the sections 18—20 of the Gasworks Clauses Act, 1847, without the exception as to the use of burners made by section 12 of the Electric Lighting Act, 1882.

2. Section 18 of the Electric Lighting Act, 1882, which expressly prohibited the undertakers from prescribing any special form of lamp or burner, is repealed; and instead, the proviso that where electricity is supplied by meter no local authority or person shall be at liberty to use any form of lamp or use the electricity supplied so as to interfere with the proper supply to other persons, is re-enacted substantively.

3. Section 27 of the Electric Lighting Act, under which local authorities may, after the expiration of 21 years, purchase the undertaking by paying the then value of all suitable lands, buildings, works, &c., of such undertakers without any addition in price, in respect of compulsory purchase, or of goodwill, or of any profits, is repealed.

4. The profits of undertakers are limited to the rate prescribed by the Provisional Order or Special Act, or where no rate is prescribed to 10 per cent. per annum. The principle whereby dividends are increased or diminished in inverse ratio to increase or diminution of price, is introduced on the method of the sliding scale applied to gas undertakings, except that having regard to the small price charged per electrical unit as compared with the price charged per 1,000 cubic feet for gas, the dividend is increased or reduced by 5s. per £100 in respect of every one farthing instead of 1d. as in the case of gas.

5. New or additional capital in the undertaking to be offered to the public by auction, in accordance with the usual auction clauses applied to gas undertakings.

6. The undertakers are to furnish a sufficient supply of electricity to owners or occupiers situate within 25 yards from the main.

7. The undertakers are to supply electricity for public lamps.

8. Mains are to be kept fully supplied.

9. Penalties similar to those of the Gas Acts are provided in case of default by the undertakers.

10. Local authorities to have similar powers of acquisition of the undertakings by agreement as are given them in the case of gas by the Public Health Act, 1875, sect. 162.

11. Penalties to be recovered summarily.

Society for the Protection of Life and Property from Lightning.—A pamphlet has reached us from Mr. W. McGregor, late Chief-Superintendent Indian Government Telegraphs, Assam division, the object of which is to set forth the necessity of a society for the protection of life and property from lightning. Steps are being taken for the formation of such a society, to consist of influential scientific and other persons, "to see that the simple rules—the outcome of patient and important scientific experiments, and the fruit of experience extending over 130 years—are not only published, but that the principles therein set forth are judiciously applied and strictly acted upon." Those who desire to learn more about the proposed society should communicate with Mr. McGregor, whose address is Kohima Lodge, Bedford.

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NOTES.

The Lighting of the House of Commons. — Speaking in the House of Commons last week, Mr. T. P. O'Connor said the Irish members found the atmosphere of the House intolerable, and that this furnished an additional reason why they should have a Parliament of their own. He hoped the electric light would be introduced into the House instead of gas. Mr. H. Fowler remarked that the electric light had been already tried, and that an enormous majority of hon. members objected to it.

Electric Lighting on Railway Trains.—The *Mechanical World* says:—"The Railway Electric Lighting Company has been formed, to work certain patents for lighting railway carriages 'by electricity generated by the *momentum* of the train, and stored in accumulators.' It would have been better if they had waited until a company had been formed to overcome the *vis inertia* of railway directors."

Electric Lighting of Museums.—Last Friday, a motion was agreed to in the House of Lords to pray her Majesty to direct the opening of the National Gallery, the British Museum, and the Natural History Museum on three week-day evenings till 10 p.m. During the discussion which took place, Lord Sudely said that danger from fire seemed now to be greatly diminished by the introduction of electric lighting, as, if properly carried out, there could be no question that this system was much less harmful and dangerous than gas. With regard to the danger of the light going out opinions differed, and it was stated that if electric lighting were arranged with duplicate plant and the building were illuminated by two distinct circuits all possibility of the danger of the rooms being left in darkness was entirely removed. Even working with a single circuit at South Kensington and Bethnal Green no trouble whatever had arisen from this cause. The greatest difficulty in connection with the whole matter was undoubtedly the question of expense. The opening and illumination of these galleries and museums at night would mean the laying down of a considerable amount of plant for the electric lighting, together with its working expenses and annual maintenance; and also the employment of additional attendants and police. The total outlay in putting down this plant was very roughly estimated at £65,000, and the annual maintenance at £6,500.

The Electric Lighting Act.—In view of the second reading of the Bill introduced by Lord Rayleigh to amend and extend the Electric Lighting Act, 1882, the Electric Lighting Act Committee, of which Lord Thurlow is chairman, has re-issued its report, a copy of which was published in the REVIEW for March 21st, 1885. The committee has arrived unanimously at the conclusion that the electric light companies should demand to be put simply in the same position as the gas companies are, both as regards their privileges and their obligations, inasmuch as they believe no satisfactory solution of the question of general electric lighting can be arrived at by amending the Act on the basis of a modified purchase option clause, and the conclusion itself is clear and intelligible, and will commend itself to the public by its fairness and simplicity. Electric light companies may safely undertake the business of general lighting under conditions entirely similar to those of the gas undertakings, and the committee has prepared the draft of a Bill, which Lord Rayleigh has presented to Parliament. While unable to accept any purchase option clause, the committee thinks it quite right that all reasonable facilities should be given to local authorities to acquire electric lighting undertakings by agreement.

Theatre Lighting.—Mr. Ernest L. Berry is again to be congratulated on the successful completion of the second year's electric lighting at the Prince's Theatre, and Mr. Edgar Bruce, the lessee, appears to be more than ever convinced of its perfect adaptability for such purposes.

Electric Lighting of Milwaukee Bridges.—A project is being forwarded to locate and operate a 2,000 candle-power electric light on each of the 24 public bridges in Milwaukee, Wis. If carried out, this, it is said, will give to Milwaukee's harbour the best illumination of any on the lakes.

Telephone Exchange at Bath.—The Western Counties and South Wales Telephone Company is about to introduce into the ancient city of Bath the undoubted benefit of a telephone exchange, which, it is considered, will be of great aid in the facilitation of business. As is customary with this company, it has notified its intention of connecting the police stations, fire office, and hospitals, free of cost. The canvass of the town has met with considerable success, and the inhabitants will very soon have the advantage of not only local telephonic connection, but also of communication with Bristol. Mr. George Glover has been appointed agent to the company for the city and district.

The Telephone in Nottingham.—The *Nottingham Express*, of the 5th inst., gave a long account of the "rise and progress" of telephonic communication in Nottingham. The article states that the service was established in May, 1881, when trade being good and premises difficult to obtain, the company considered itself fortunate in securing the present Central Exchange in Bottle Lane. The exchanges (local) of the company are at Bottle Lane, Basford, Long Eaton, Loughborough, Ilkeston, and a call office has just been opened at the top of Derby Road, Nottingham. The company has about 316 miles of wires (chiefly overhead), exclusive of 40 miles erected for the use of the Municipal Corporation and its various departments. By this means the Municipal Offices in Albert Street are in constant communication with all the police and fire brigade stations, the Castle, the Eastcroft, the University College, Water and Gas Offices and Works, and the Borough Asylum. The Workhouse is also in communication with the Training Institution at Radford. A very large number of warehouses, offices, and factories are also connected with the system. There are now about twenty private residences in connection with the system. One very general application of the telephone is to put the residences of merchants and manufacturers in connection with their offices and works, both in the town and neighbourhood. Bottle Lane and all the subscribers are in direct communication with Loughborough, Long Eaton, Ilkeston, Bulwell, Basford, Carlton, Kimberley, and Arnold. The latest departure in connection with the local telephone is the establishment of a call office at the shop of Mr. Swinburne, watchmaker, in a block of recently-erected premises on the top of Derby Road, nearly opposite the General Cemetery gates. This office is now open to subscribers and the general public, and anyone in that locality by going there may communicate with the residence, office, or other place of business of any of the 337 subscribers who are connected with Bottle Lane, the public offices departments, police and fire stations, or principal public institutions. These call offices have been most successful in other parts of the country, more especially in the West Riding of Yorkshire, and it is felt that this single one, a preliminary experiment, only requires to become known and freely used to receive a large share of public patronage and favour. In that event, the company intends opening similar offices in all the other districts of the town.

The Proposed Telephone Conference.—Mr. W. E. Irish has sent us a lengthy communication upon this subject in reply to the letter of "Telephonist" in our last issue, but as much that he writes is beside the question, and is not likely to interest our readers, we are unable to publish it in full. Mr. Irish states that

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all patents for telephones which he has taken out are now public property; he then proceeds to describe in detail forms of his instruments which were fully dealt with in the REVIEW in the month of August last. These, he asserts, are outside the rightful claims of the United Telephone Company; but he has nothing to say upon the question whether they are (as has been contended) infringements of Prof. S. P. Thompson's inventions or not. His object, he says, in proposing a conference was to enable electrical engineers to consult together as to the best means of protecting themselves and their customers against "the monopoly." Such a conference might, he thinks, consider the advisability of opposing any application which may be made for the extension of the term for which patents have been granted to Bell and Edison, and of introducing a Universal Co-Operative Telephone Exchange System in every town throughout the country, by means of which the rentals would be reduced to a fractional part of the present cost. It might also protest against the State purchase of the monopoly, which is considered, in some quarters, to be probable. Mr. Irish may think that the discussion of these subjects will result in general benefit, but we have serious misgivings. We doubt if the opinions expressed at any assembly likely to take place upon the suggestion which Mr. Irish has made in our columns would carry much weight,

Improvements in Telephony.—An automatic call-box, the invention of Messrs. Blakey, Emmott & Co., Halifax, has just been brought into use at the call stations of the National Telephone Company at Bradford. One of the ordinary telephone instruments is fixed at the call station, which is usually a cabman's shelter or a tradesman's shop, and the automatic apparatus is fixed at the side of the instrument. Upon the person who wishes to speak dropping three penny pieces—a threepenny piece won't do—into the box, the weight of the coins moves an electric lever, which puts the speaker in communication with the exchange. On completion of the conversation, the exchange operator by reversing the current can break the connection again, and it requires three more pennies to obtain a further hearing. It is anticipated that these automatic boxes, which do away with the necessity for employing an attendant, will, if they prove satisfactory, enable the Telephone Company to extend its system of call stations considerably.

The Installation of Telephones on a Steamer.—We have received particulars of the installation of telephones on a steamer mentioned in our impression of March the 5th. The vessel was the *Anglo-Indian* steamer. The number of instruments was four, namely, one in engine room, one in steward's room aft, and two in the captain's deck house, and the circuits were deck house to engine room and deck house to steward's room, no switches being used. Wires had been run under the deck planks, but were found faulty, and new wires were run, while the frame of the ship was used as return circuit. "Earth" connection was made by soldering a strong wire on to a piece of galvanised iron plate one quarter inch thick, the plate being rivetted on to one of the ship's frames. The instruments were reported as working well a year after they were erected. The captain, who was also owner of the ship, is entitled to great credit for his enterprise, especially as it was quite in the early days of the telephone.

Long Distance Telephone Experiments.—Four new iron wires have lately been erected by the Post Office between London, Manchester, and Liverpool, on the "twist" or anti-induction principle. Some telephonic experiments were carried on between these places, but speaking was found to be practically impossible. Had these wires been constructed of copper, no doubt is expressed, from the result of Prof. Hughes's discoveries, that speaking would have proved to have been practical.

Local Authorities and Telephone Wires.—The Bill of the Nelson Local Board came before the Court of Referees (Mr. C. S. Parker in the chair) at the House of Commons last week, on the petition of the Lancashire and Cheshire Telephonic Exchange Company, Limited, for a *locus standi* to appear against the Bill. The Court decided that, as Parliament was very jealous of local authorities obtaining such legislative powers as were sought by the Bill unless the parties affected were heard upon the petition, in this case the *locus standi* would be allowed. We are informed that the Western Counties and South Wales Telephone Company has also succeeded in maintaining a *locus standi* against the Torquay Harbour Bill, in which the promoters have put a similar clause to that in the Bill referred to above.

Abbreviated Telegram Addresses.—Lord Wolverton, The Postmaster-General, has been memorialised from Yorkshire to reduce the amount charged for the registration of telegraphic addresses from £1 1s. to 5s. His Lordship has replied that the actual cost the department incurs in respect of each registration considerably exceeds the sum of 5s., and that any balance that may remain out of the charge of one guinea is far from being sufficient to meet the loss of revenue arising out of the reduction in the number of words in telegrams which is brought about by the use of an abbreviated address. The system is one which the department could never recommend to the public, and his Lordship considers that it would be contrary to his duty to do anything which would encourage any great extension of the system.

Electricity in the Royal Navy.—The electric light arrangements on board the barbette ship *Collingwood* at Portsmouth are now complete, the work having been carried out by Messrs. Siemens Brothers. The system employed is precisely the same as that on board the *Imperieuse*, a description of which has already appeared in these columns. There are altogether about 420 incandescent lamps distributed over every part of the ship. The electric light machinery on board the *Defiance* torpedo school ship at Devonport was tested on Friday last under the superintendence of Mr. Francis Ford, chief engineer of the ship, and Mr. Charles Rudd, second assistant to the chief engineer of the dockyard. A compound surface condensing engine drives the dynamo-electric machinery by the intervention of shafting and belting. The trial was pronounced to be highly satisfactory. Some interesting experiments were made at Dover last Friday with the 80-ton guns, which were fired by electricity. In all, eight charges were fired, six of these being full charges of 450 lbs. of prism. Excellent practice was made, and only one window in the town was broken.

To relieve the pressure in Portsmouth Dockyard some of the vessels are to be transferred to other yards. Though Portsmouth Yard is to continue the headquarters for torpedo fittings and experiments, it is intended to relieve it as a centre for the supply of electrical fittings for the fleet. It is consequently proposed to establish an electrical staff at Chatham, Sheerness, and Devonport, and as many trained workmen as can be spared are to be sent to those yards from Portsmouth.

The Development of Dynamic Electricity.—In the journal of the Franklin Institute for this month there appears a paper by Professor W. D. Marks, of Pennsylvania University, on "The development of dynamic electricity," in which he deals with the conversion of heat into electrical energy; the conversion of electrical energy into light; and the conversion of electrical into mechanical energy.

Partnership.—Mr. H. C. Harold, who is well known in connection with specialities in electric light fittings, has taken into partnership Mr. Robert Jenkins, and in future the name of the firm will be Harold and Jenkins.

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The Electric Tramway at Ryde.—The president of the South-west of England District Association of Gas Managers has evidently not made himself well acquainted with the progress of electric tramways in the United Kingdom, if one may judge from his remarks after the opening of the Ryde Pier line. But as his comments were *post prandial*, some licence may perhaps be allowed.

FitzGerald's Secondary Battery.—With reference to Mr. FitzGerald's letter in our last issue M. Hospitalier writes to that gentleman as follows:—"You have altogether misinterpreted my letter to the ELECTRICAL REVIEW. I have said and I *maintain*, that the persons who have declared that I have made a report upon your battery have misused my name. This accusation is addressed to those who have supplied *false* information to the *Electrical Engineer*. I have therefore absolutely nothing to withdraw from the expressions of my letter. If you know the persons who have supplied the information to the *Electrical Engineer*, you can explain to them for me that I consider them as unscrupulous persons since they have made an absolutely false statement."

We regret that through a clerical error the translation of M. Hospitalier's letter to us, which was published in our "Notes" column for the 5th inst., made it appear that Mr. FitzGerald had been guilty of unduly making use of M. Hospitalier's name. The paragraph should have read "I consider the use which has been made of my name," &c., not "which *he* has made of my name." We ask Mr. FitzGerald's pardon for the unfortunate slip and take great pleasure in making the above correction.

Testing the Commercial Efficiency of Dynamo Machines.—Writing to the *Engineer* from the College of Science and Arts, Glasgow, Mr. Andrew Jamieson, the principal, says: In Mr. Kapp's description of the tests carried out at Messrs. Mather and Platt's works on the two Edison-Hopkinson dynamos, which appeared in the *Engineer* of last Friday, he gives at page 195, second column, the E.M.F. of Latimer Clark's cell as 1·453 volts. Now, in the report issued by Messrs. Mather and Platt it is stated that Lord Rayleigh's determination of the ohm and of the volt have been taken and not the B.A. units, consequently, if he accepted their resistances of the armature and field-magnets, &c., as stated in legal or in true ohms, the E.M.F. of the Clark cell used in connection with the experiments would of necessity also require to be reckoned in legal or in true volts, or about 1·12 per cent. less, say 1·441 legal volts. See Lord Rayleigh's latest communication to the Royal Society, January 21st, 1886, wherein he gives the E.M.F. of a standard Clark cell as being on August, 1885, = 1·4537 B.A. volts.

Lighthouse Illuminants.—The paper read on the 10th inst. on "Experiments with Lighthouse Illuminants at the South Foreland," by Mr. E. Price Edwards, before the Society of Arts, is published, together with the discussion thereon, in the Society's journal for last week. There is much contained therein of interest to the electrical engineer, the remarks of Mr. R. E. Crompton being very much to the point, for he shows that the electric light can as well be used for a small light as a big one, and that then instead of being two-and-a-half times dearer than oil, its cost might be reduced to one-and-half times less.

Secondary Battery Regulation.—A friend suggests that the trouble experienced by Mr. Littleton with the fluctuation of his incandescent lamps when the charging and discharging currents are about equal, is due to his gas engine. That is probably the case, but secondary batteries have hitherto been supposed to be capable of eliminating the irregular speed of motors. Is it not more likely that when the two currents are equal the secondary cells have nothing to give or take, and that, therefore, the pulsations in the dynamo current are then as apparent as if no battery is used in conjunction therewith. It does not appear from the correspondence on this subject that any others have worked under the precise conditions stated by Mr. Littleton.

The Resistances of Conductors.— Mr. J. Munro suggests that as a result of the experiments of Prof. Hughes on self-induction, it seems that the resistance of wires cannot be the same with a dynamo current that it is with a battery current. The latter is constant, the former intermittent, or, at all events, fluctuating. It follows, then, that conductors measured with battery currents will have different resistances with dynamo currents. This fact, says Mr. Munro, is certainly worth looking into to see what the difference amounts to and the practical value in electric lighting, &c. He also suggests that conductors for dynamo work should be measured with dynamo current and those for battery work with battery current; of course, "standards" made by battery currents will also give different values with dynamo currents if what is supposed be true.

At first sight it would appear that Mr. Munro's arguments might have considerable weight, but further consideration makes us more doubtful on the point. Everyone knows that when the resistance of an electro-magnet is being measured by means of a Wheatstone bridge, then if the galvanometer key is held down and the battery key is alternately raised and depressed, a series of "kicks" are obtained on the galvanometer; if a true resistance balance pure and simple has been obtained in the first place, then the kick on depressing the battery key is the same as that obtained on raising the key, but in the reverse direction. If now these makes and breaks occurred very rapidly, these kicks would annul each other and the needle would remain steady at zero, in other words a true resistance balance would be obtained; this would also be the case, we think, when a pulsatory current such as that given by a dynamo is being dealt with, especially with a galvanometer sluggish in its movements. We may add that Mr. Carl Hering, to an extent, forestalls Mr. Munro, as may be seen by referring to p. 250, line 5, of our present issue.

The First American Electric Patent.—In his recent lecture on Historical Electrical Apparatus, before the Franklin Institute, Chief Examiner Kintner, of the Electrical Department in the Patent Office at Washington, says the first electrical patent was granted to D. Harrington, a Philadelphian, in 1833, and that prior to 1881 there was no separate class for electrical patents. In that year it was made a separate class. The lecturer gave praise to the workmanship exhibited in models filed for patents.

An Appeal on Behalf of a much-valued Servant.—We should be spared the necessity of overburdening our capacious waste-paper basket, if Dr. Shaw, *alias* C. Frazier, *alias* Bonco, *alias* Blank, *alias* Banks, *alias* A. Lefevre, would for a time withhold his communications. We do not like to be cruel, but really what he has to say does not interest us much.

The De Khotinsky Secondary Battery.—Messrs Shippey Bros. send us the following:—It having fallen to the lot of our firm to instal the first set of batteries in England of the above system, we shall have much pleasure in allowing your correspondent, Mr. R. Mitchell, to inspect same, when he will find the batteries running side by side with the E.P.S. and Dr. Woodward's standard battery; he will then be able to judge for himself as to the difference between the three systems.

The Royal Society of Edinburgh.—A meeting of the Royal Society was held on Monday night, Sheriff Forbes Irvine, of Drum, vice-president, in the chair. Professor Blyth described a method of finding the strength of an electric current by means of an adaptation of the chemical balance.

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The Railway Electric Lighting Company, Limited.—This company, recently alluded to in our pages 216 and 217, had, we understand, applications made for more than the full amount of capital offered. As, however, some three separate inventors had sent in legal notices of the invalidity, by reason of their respective patents, of the Houghton-Stroudley inventions, it was deemed advisable to return the applicants their moneys in full. The company entitled the Railway Electric Contractors, Limited, will, it is said, carry on the business as before, and for that purpose, and to extend the same, will take more capital; and thus the aims of those who served the afore-mentioned notices will be, justly or unjustly, at least for a time, defeated.

Edinburgh International Exhibition.—At a meeting of the executive committee, last week, it was resolved to light the grounds by electric light, supplemented, if necessary, by variegated Chinese lanterns artistically distributed amongst the trees. The tender by Messrs. King, Brown and Co., for electric lighting, was accepted.

Removal.—Mr. Ronald A. Scott has removed from 31, Basuto Road, Fulham, to larger premises at 331, King Street, Hammersmith, W.

Accumulator Plates.—A correspondent writes, just as we go to press, asking if there is any valid patent for the application, by mechanically spreading, of peroxide of lead or minium to the plates of secondary batteries.

The Holmes-Burke Primary Battery.—It is stated that at a recent trial of the Holmes-Burke primary battery, 40 of these cells lighted a Brockie-Pell lamp of 2,000 candle-power, taking 12 ampères for 17½ hours continuously with a single charge.

Fatal Gas Explosion.—On Tuesday afternoon two children were killed and six persons injured by an explosion of gas in a house in Coppall Lane, Wigan. As no gas was used in the house it is probable a searching inquiry will be made to ascertain from whence it escaped.

Gas Engines.—Gas-engine litigation, remarks *Gas and Water*, has had its innings in England, in Germany, and in France. Recently an agitation of a different nature, yet relating to gas-engines, arose in America. In the Republic, as elsewhere, the makers of the Otto gas-engine claim a large percentage of economy for it, and they court and have courted comparison with other makers in this respect. At the American Institute Exhibition one of these engines was entered for competition. The challenge was accepted by the Clerk Gas-Engine Company, and the conditions were duly announced. The exhibitors were to supply the weight of the engine, price, claimed horse-power, and the test was stipulated to last two hours for each engine at full power, and was to bear upon the economy as well as the power of the engine. Four well-known engineers acted as judges, and they report that "the results as regards consumption of gas were practically identical—the difference being only one-fifth of a cubic foot per effective horse-power per hour. Outside of this we find very commendable features in both engines, especially in the Clerk; but in view of the paramount importance of the item of consumption of fuel in gas-engines, we do not feel justified in deciding upon the relative merits of both engines solely upon points of design and workmanship, and, therefore, we would recommend a more thorough and longer test, which will bring out the difference in economy, if any, or prove beyond question the equal standing of the two engines on that score." From the statement of the tests it appears that the cubic feet of gas used per hour was:—Otto 236·55, Clerk 293·65; horse-power by brake, Otto 9·6, Clerk 12·007; cubic feet of gas per brake horse-power per hour, Otto 24·64, Clerk 24·44 These facts speak for themselves.

Messrs. H. and E. J. Dale's Catalogue.—The third edition of this descriptive price list of electrical and physical apparatus has just been issued. It is not only a price list, but also a guide to the use and fitting of all forms of apparatus, useful alike to the science teacher, the amateur or experimentalist and the commercial buyer. The prices are revised to date, and many novelties are described and illustrated in this new issue.

Electric Light at the Aquarium.—At the close of last year the lighting of this place of amusement, which has recently, by dint of vigorous management, regained much of its former popularity, was placed in the hands of the Gülcher Electric Light and Power Company. The installation has now been in successful working for nearly three months, and the brilliancy and steadiness of the lights has been a marked success. There are seven lamps of 2,000 candle-power lighting the exterior of the building and 16 of 3,000 candle-power throughout the interior. The whole are fed from three 65 volt machines driven by a 16 H.P. Robey engine.

The Society of Telegraph-Engineers and Electricians.—The next meeting at the Institution of Civil Engineers, 25, Great George Street, S.W., will take place on Thursday, the 25th March, at 8 p.m., when the following paper will be read:—"Electric Lighting by Means of Low Resistance Glow Lamps," by Alexander Bernstein.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Pocklington New Lighting Company, Limited (gas and electricity).—The first annual return of this company, made up to the 8th inst., was filed on the 9th inst. The nominal capital is £3,000 in £1 shares; 1,277 shares have been taken up and a call of 2s. 6d. was made upon allotment. The total calls paid, including those paid in advance, amount to £269. Registered office Union Street, Pocklington, York.

Maxim-Weston Electric Company, Limited.—The annual return of this company, made up to the 5th inst., was filed on the 15th inst. The nominal capital is £125,000, divided into 500,000 shares of 5s., having been recently reduced by £62,500 by cancelling paid-up capital unrepresented by available assets (being patents over-estimated in value). The total amount of calls received is £61,700, and £800 is considered as paid on 3,200 shares.

Jarman Electrical Company, Limited.—An extraordinary general meeting of this company was held on the 22nd ult., at 6, Great Winchester Street, when the following resolution was passed: "That the liquidator be authorised to waive and cancel the agreements entered into between the Jarman Company, C. P. Eliesen and Edwd. Spendlove, as trustee on behalf of the Electric Locomotive and Power Company, Limited, and between the liquidator, C. P. Eliesen and the last named company, dated respectively, 31st July, 1885, and 19th September, 1885, and in lieu thereof to enter into a fresh agreement proposed to be made between the liquidator of this company, C. P. Eliesen, and the Electric Locomotive and Power Company, Limited, for the sale of the business effects and property of the Jarman Company in consideration partly of fully paid-up shares in the Electric Locomotive and Power Company, Limited, and cash and bills to be paid, given, and transferred upon the terms and conditions set forth in the draft of the said agreement, and which draft, for the purpose of identification, is signed by the chairman, Mr. George Hamilton." This resolution was confirmed on the 10th inst. and duly filed on the 15th inst.

Simplex Electrical Syndicate, Limited.—An agreement dated 27th ult., and filed on the 10th inst., relates to the purchase by this company

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of the business of electricians carried on by Messrs. G. Alanson Mason, Otto Romanze, Fredk. Thornton, and Wm. Weise, at 9, North Street, Wandsworth, together with certain patented and other inventions relating to the construction of electric arc lamps, secondary batteries, or electrical accumulators, and other electrical apparatus and appliances. The purchase consideration is £300 in cash and 60 fully paid shares of £50 each.

International Electric Company, Limited (in liquidation).—The registered office of this company is now situate at 14, George Street, Mansion House.

CITY NOTES, REPORTS, MEETINGS, &c.

Direct Spanish Telegraph Company, Limited.

THE report of the directors states that the accounts for the half-year ended December 31st, 1885, show, after paying for the repairs of the new Bilbao cable (£2,959 13s. 7d.) and providing for debenture interest, a balance to the credit of profit and loss of £1,449 5s. 2d.

The traffic receipts show an increase of £287 14s. 9d. as compared with the corresponding half-year of 1884, and an increase of £1,111 12s. over those of the last half-year.

The repairs of the new Bilbao cable, the interruption of which was mentioned in the last report of the Board, were promptly and economically effected. The cause of this break, which occurred in very deep water, cannot be ascertained. The entire cost of these repairs, it will be noticed, has been paid out of the revenue for the half-year.

The new Bilbao cable has, since the repairs, worked perfectly. The Marseilles-Barcelona cable has remained in excellent working order throughout the half-year.

The directors are arranging to have the original Bilbao cable examined in the course of this summer, with a view to ascertain its condition.

The directors propose to put £1,400 to the reserve fund, which will then amount to £9,800, and to carry £49 5s. 2d. to the next account.

The Telephone Company of Egypt, Limited.

THE ordinary general meeting was held on Tuesday at the offices, Austinfriars, Lieutenant-General A. Fraser, C.B., R.E., in the chair. The report of the directors stated that, including the balance of £165 brought forward, there was an available balance (after providing for income tax and writing off £300 in reduction of capital for depreciation) of £3,210, out of which they recommended a dividend at the rate of 5 per cent. per annum, leaving a balance of £192 to be carried forward. The dividend now payable had, in accordance with the articles of association, to be applied in the following manner :—2 per cent. in final payment of the cumulative preferential dividend of 7½ per cent. per annum for 1883, and 3 per cent. in part payment of the cumulative preferential dividend of 7½ per cent. for 1884, leaving 4½ per cent. for the year still due. In order, however, that the earnings of the present and future years might be applied specially to the payments of dividends for those years for which the accounts were issued, an alteration of the articles of association was now contemplated. On the motion of the chairman, seconded by Mr. G. B. Frost, the report was adopted and the dividend recommended declared. The retiring directors and auditors were afterwards re-elected.

National Company for the Distribution of Electricity by Secondary Generators, Limited.—The third ordinary general meeting of this company was held at the offices, Warwick Street, Regent Street, on Thursday, under the presidency of Mr. Wm. D'Oyly, when the report, printed in our last issue, was adopted, and a dividend of 10 per cent. on the preferred shares was declared.

German Union Telegraph and Trust Company, Limited.—A final dividend of 4s. 3d. per share is recommended, free of income-tax, on the 22nd inst., making a total dividend of 10s. on the year to December 31st, 1885.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th March are £2,892, as compared with £2,865 in the corresponding period of 1885.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 12th were £2,449, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts of last week amounted to £3,032.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, March 11th, Professor HUGHES, F.R.S., president in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a paper on "Economy in Electrical Conductors," by Professors W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S., was read as follows :—

I.—At the meeting of the British Association in 1881, a most valuable solution of a very important problem was given by Sir William Thomson regarding the proper sectional area to give to a copper conductor used in transmitting electric energy. In the account of his communication given in the "Report of the British Association" for that year, it is stated that "he remarked that (contrary to a very prevalent impression and belief) the gauge to be chosen for the conductor does not depend on the length of it through which the energy is to be transmitted. It depends solely on the strength of the current to be used, supposing the cost of the metal and of a unit of energy to be determined." And he concluded that for twelve hours per day work "the sectional area of the wire in centimetres ought to be about a fiftieth of the strength of the current in webers."

It is, of course, well known that this rule has to be departed from when considerations have to be taken into account other than that of obtaining maximum economy : for example, the necessity in any general system of electric lighting of maintaining the potential difference along the mains constant within certain limits, may lead us to adopt a thicker conductor than is given by the rule of 1 square centimetre per 50 ampères ; while on the other hand, our desire to obtain a large magnetic effect in an electromagnet, or a large electromotive force in a dynamo, induces us to employ a much thinner conductor than the rule indicates. But, at any rate, when the cost of copper and the cost of coal are the leading considerations, it might appear that Thomson's rule ought to be rigidly adhered to, proper allowance being, of course, made in any particular case for the number of hours of working, the cost per ton of copper, the annual rate of interest and depreciation, and the annual cost of an electric horse-power. Indeed, this is the view that we, and possibly other electrical engineers, have taken, and it was not until comparatively recently, when in actual calculations regarding the proper dimensions to give to the conductors in telpher lines, that we recognised that Thomson's solution of the most economical section to give to a conductor was quite inapplicable in a variety of cases connected with electric transmission of power.

II.—Let us consider a little more in detail the solution that Thomson gave. He arrived at an expression for the total waste per mile in a conductor arising from the generation of heat and interest on copper which we find convenient to put in the following form :—

$$c^2 r + \frac{t^2}{r} \qquad (1)$$

where c is the current in ampères, r the resistance of the conductor per mile in ohms, and t a constant which depends on the annual interest on the value of a ton of copper (allowing for depreciation) and the annual cost of an electric horse-power for the number of hours per year that power is required. Our expression (1) is, in fact, the *total* rate of waste per mile, *reckoned in watts.**

In order that this may be a minimum for a given value of c,

$$c = \frac{t}{r}. \qquad (2)$$

If we take £15 as the annual interest (allowing for depreciation) per ton of copper (that is to say, about 12 per cent. on £125—a fair price per ton for good conductivity copper, including the value of the necessary amount of insulation), and if we take £15 also as the annual cost of an *electric* horse-power for the number of hours per year that power is required, it is easy to show that

$$t^2 = 297 \cdot 3;$$

so that (2) reduces itself to

$$c = \frac{17 \cdot 24}{r}$$

$$= \frac{17}{r} \text{ approximately} \qquad (3)$$

corresponding with about 60 ampères per square centimetre, or 393 ampères per square inch.

Now suppose that we desire to apply this result to such a case as the following, which will frequently be met with in electric lighting and transmission of power :—What size of copper conductor ought to be employed when a certain amount of power, P watts, has to be furnished at the end of a conductor n miles

* Although it would not avail bankers to reckon that a business which cleared £1,500 a year produced so many watts, yet such a mode of reckoning is very convenient in problems like the one under consideration. With an electric horse-power costing £15 per annum the business clearing £1,500 annually might be regarded as producing 74,600 watts, and 5 per cent. per annum interest on £120 might be regarded as an income of 298·4 watts.

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long, and when the highest potential difference we are allowed to use from considerations of safety, or, it may be, that is allowed us by the Board of Trade, is V volts?

Let C be the current in ampères, then, since the maximum potential difference must be at the near, or dynamo, end of the line, the potential difference at the farther end will be

$$V - C n r,$$

if r is the resistance per mile of the conductor in ohms, and if the earth be used as the return; or if r is the resistance per mile of the going and returning conductor,

$$\therefore P = C (V - C n r) \qquad (4)$$

and, by Thomson's rule,

$$C = \frac{t}{r};$$

hence we have two equations from which to determine C and r. The values of C and r so obtained are—

$$C = \frac{P}{V - n t} \qquad (5)$$

and

$$r = \frac{t (V - n t)}{P} \qquad (6)$$

and these are the values of C and r which, it might appear, ought to be selected in order to obtain maximum economy.

As an example, let

$$P = 10{,}000 \text{ watts},$$
$$V = 200 \text{ volts},$$
$$n = 10 \text{ miles},$$
$$t = 17;$$

then, from (5) and (6),

$$C = 333 \text{ ampères},$$

and

$$r = 0{\cdot}051 \text{ ohm}.$$

But it is easy to see from (4) that with an initial potential difference of 200 volts the same power, 10,000 watts, can be delivered at the end of 10 miles of a conductor having the same resistance per mile if, instead of using 333 ampères, we use only 59 amperes; and as the loss of power in heating is proportional to the square of the current, the waste in heating when using the smaller current will be only about the twenty-sixth part of what it would be if we used the current given us by equation (5).

In fact, for each value of r there are two solutions of C which satisfy (4), whereas only one of them can satify Thomson's equation of economy (2). In this example, then, 31 times as much economy in coal will be obtained by neglecting Thomson's rule as by following it.

III.—Now what is the explanation of this? The cause cannot, of course, be due to any error in Thomson's reasoning, and it arises from the fact that Thomson's solution gives the minimum value of the expression

$$C^2 r + \frac{t^2}{r}$$

only when C is regarded as a constant, and r as the *sole* variable. But if, as in the present case, both C and r in this expression are variables connected by some equation such as

$$f(C, r) = 0,$$

then the equation connecting C and r which makes the total waste a minimum is *not*

$$C = \frac{t}{r}.$$

In fact, when the maximum difference of potentials, V, is fixed, the current, C, can only be regarded as a constant when the power *put into the line at the dynamo end*, V, C, is given, and when the amount delivered at the other end is, so to say, left to chance. Under these conditions Sir William Thomson has given us a most useful rule for determining the size to give to the conductor to obtain maximum economy, but his solution can only be used when the value of the current is previously known.

But since in many practical cases it is the amount of power that has to be furnished at the distant end of the line that is fixed for us by the contract, C must not be regarded as a constant, and a totally different method must be employed to obtain the size of conductor to be employed so that the waste of power in heating the conductor, together with the interest on the value of the copper, may be a minimum. For not merely, as we have shown, does the current of 333 ampères and a resistance of 0·051 ohms per mile, as determined from (5) and (6), lead to 31 times as much waste in heating as will be produced by using the equally effective current of 59 ampères with the same conductor, but, as we shall show, there is a solution of the problem even more economical than this.

IV.—If we write F (C, r) for the total rate of waste, which is

$$C^2 r + \frac{t^2}{r},$$

and if our supply condition connecting C and r is

$$f(C, r) = 0,$$

then the equation which gives us the minimum is

$$\frac{d F}{d C} \times \frac{d f}{d r} - \frac{d F}{d r} \times \frac{d f}{d C} = 0.$$

Hence, performing the partial differentiations on our two functions (1) and (4), we have

$$2 C r \times C^2 n - \left(C^2 - \frac{t^2}{r^2}\right)(2 C n r - V) = 0 \qquad (7)$$

Eliminating r from (4) and (7), we obtain

$$C^2 - 2 C \frac{P}{V} + \frac{P^2}{V^2 + n^2 t^2} = 0 \qquad (8)$$

$$\therefore C = \frac{P}{V}\left(1 \pm n t \sqrt{\frac{1}{V^2 + n^2 t^2}}\right),$$

and, as C V, which is the power put in at the dynamo end of the line, must necessarily be greater than P, the power given out at the distant end, it follows that the plus sign is alone admissible. Hence the current which must be used to obtain maximum economy is

$$\frac{P}{V}\left(1 + n t \sqrt{\frac{1}{V^2 + n^2 t^2}}\right) \qquad (9)$$

Substituting the values employed in the previous example for P, V, n, and t, we find that the current which gives maximum economy is 82 ampères; and, from (4),

$$r = \frac{C V - P}{C^2 n}; \qquad (10)$$

so that the resistance per mile that gives maximum economy is 0·0954 ohm, and *not* 0·051 ohm.

We may now use the three sets of values of C and r that we have obtained in connection with our example, and find what values they give to the expression

$$C^2 r + \frac{t^2}{r},$$

which represents the total rate of waste, reckoned in watts, due to the production of heat in the conductor, and to the interest, including depreciation, on the value of the conductor.

A. Using the values of C and r given by (5) and (6), obtained from combining Thomson's condition of maximum economy with the condition of electrical supply, we have for the above expression

$$333^2 \times 0{\cdot}051 + \frac{289}{0{\cdot}051} = 5{,}654 + 5{,}666$$
$$= 11{,}320 \text{ watts per mile.}$$

B. Using the value of r given by (6), and the second value of C given by (4), we have for the above expression

$$59^2 \times 0{\cdot}051 + \frac{289}{0{\cdot}051} = 177 + 5{,}666$$
$$= 5{,}843 \text{ watts per mile.}$$

C. Using the values of C and r given by (9) and (10), the proper equations to be used for obtaining maximum economy, we have for the total waste

$$82^2 \times 0{\cdot}0954 + \frac{289}{0{\cdot}0954} = 641 + 3{,}030$$
$$= 3{,}671 \text{ watts per mile.}$$

Although, then, the current of 82 ampères and the resistance of 0·0954 ohms per mile lead to a greater waste in heating than the current of 59 ampères and the resistance of 0·051 ohms per mile, yet the former are the most economical to employ. In fact, it will be found that a conductor having a resistance per mile either greater or less than 0·0954 ohms leads, in our example, to greater waste than is produced by employing this conductor.

V.—For the purpose of constructing a table to be used for determining the proper current and resistance of conductor per mile to be selected in various cases in order to obtain maximum economy, and for determining the waste that will occur per mile in heating, and the amount of interest on the value of the copper per mile, when this current and resistance per mile are employed, let

$$\frac{n t}{V} = \tan. \phi;$$

then

$$C = \frac{P}{V}(1 + \sin. \phi) \qquad (11)$$

and

$$r = \frac{V^2}{n P} \cdot \frac{\sin. \phi}{(1 + \sin. \phi)^2} \qquad (12)$$

Using these values, the following table (No. I.) has been calculated for V equal to 200 volts, and P equal to 20,000 watts, for the purpose of illustrating the variations in current, resistance per mile, &c., proper to be employed to obtain maximum economy with wires of various lengths. The first column gives n, the number of miles at the end of which this power is to be furnished if the earth be used as the return. If the earth be not used as the return, then n will be *twice* the distance between the two ends of the line. The second column is $\frac{n t}{V}$, where t is taken as 17. The third and fourth columns give ϕ, and sin. ϕ; the fifth and sixth the current (C) in ampères that should be employed, and the resistance (r) in legal ohms per mile that should be given to the conductor to obtain maximum economy; column 7 gives the sectional area (A) of the conductor in square inches, the resistance of one mile of copper wire of 98 per cent. conductivity at 20° C., one square inch in section, being taken as 0·04378 legal ohms. Column 8 gives D, the current density—that is, the number of ampères per square inch; columns 9 and 10 P_1, the power, in watts, wasted in heat per mile, and P_2, the watts wasted per mile as interest, including depreciation, on the value of the conductor. The last column contains the values of P_3, the total rate of waste, in watts, per mile.

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TABLE I.

To furnish 20,000 watts at the end of n miles.

1	2	3	4	5	6	7	8	9	10	11
n	$\frac{17}{200} n$	ϕ	sin. ϕ	C	r	A	D	P_1	P_2	P_3
·1	·0085	0° 29′	·0084	100·8	·1652	·2651	380·2	1679	1749	3428
·5	·0425	2° 26′	·0425	104·3	·1564	·2800	372·5	1699	1847	3546
1	·085	4° 52′	·0848	108·5	·1441	·3038	357·2	1695	2005	3700
2	·17	9° 39′	·1677	116·8	·1229	·3563	327·8	1675	2351	4026
4	·34	18° 47′	·322	132·2	·0921	·4753	278·1	1609	3137	4746
6	·51	27° 2′	·4545	145·5	·0716	·6115	238·0	1514	4036	5550
8	·68	34° 13′	·5623	156·2	·0575	·7614	205·1	1403	5026	6429
10	·85	40° 22′	·6477	164·8	·0477	·9179	179·5	1295	6058	7353
15	1·275	51° 54′	·7869	178·7	·0328	1·335	133·9	1047	8810	9857
20	1·7	59° 32′	·8619	186·2	·0241	1·817	102·5	835	11911	12746
30	2·55	68° 35′	·931	193·1	·0166	2·637	73·2	618	17530	18148
50	4·25	76° 46′	·9735	197·4	·0099	4·423	44·6	385	29191	29576
70	5·95	80° 27′	·9861	198·6	·0071	6·166	32·2	280	40704	40984
100	8·5	83° 18′	·9932	199·3	·0049	8·935	22·3	194	58979	59173

The latter portion ef this table has been calculated merely for the purpose of illustrating how the current, sectional area of the conductor, and current density necessary to be used to obtain maximum economy vary with the length of the line, and not because anyone would think of attempting to transmit 30 horse-power 50 or a 100 miles with a potential difference of only 200 volts at the dynamo.

The problem considered by Sir William Thomson led to the result that in order to obtain maximum economy the area of the conductor depended solely on the current, and was independent of the length of the line, or, in other words, the current-density was a constant. But from the preceding table we see that *if a given amount of electric power has to be furnished at the end of a line, with a given potential difference at the dynamo, maximum economy is obtained, not by keeping the current-density constant, but by making it diminish as the length of the line becomes greater.*

In order to employ this table for other amounts of power to be furnished at the distant end of the line, it is to be observed that since

$$\text{C} = \frac{\text{P}}{\text{V}} (1 + \sin. \phi) \qquad (13)$$

$$r = \frac{\text{V}^2}{n \, \text{P}} \cdot \frac{\sin. \phi}{(1 + \sin. \phi)^2} \qquad (14)$$

and since the sectional area of the conductor,

$$\text{A} = \frac{0·04378 \, n \, \text{P}}{\text{V}^2} \cdot \frac{(1 + \sin.\phi)^2}{\sin. \phi} \qquad (15)$$

it follows that, with the same initial potential difference, the most economical current to employ is directly proportional to the power to be furnished at the distant end, the most economical resistance per mile to give to the conductor is inversely proportional, and the most economical sectional area directly proportional, to the power that has to be furnished at the distant end of the line.

VI.—In the construction of telpher lines we use steel rods both to carry the load and to carry the conductor. In order, then, to see how the numbers in Table I. must be altered if steel be used instead of copper, we must see how the value of t is altered. Now, since

$$t^2 = 67·84 \frac{i \times c \times \rho}{p},$$

where i is the yearly interest, including depreciation, on money invested in conductors; c the value, in pounds, of a ton of the metal used in making the conductor, together with the value of the necessary amount of insulation; ρ the resistance of a wire one mile long and one square inch in section of the material employed in making the conductor; and p the annual cost, in pounds, of an electric horse-power for the number of hours that power is required. Now the specific resistance of steel bears to the specific resistance of copper, approximately, the inverse ratio of the cost per ton of steel to the cost per ton of copper; hence the product $c \, \rho$ for steel will be roughly the same as the $c \, \rho$ for copper, and consequently the value of t may for a rough approximation be regarded as unaltered. All the columns, therefore, in Table I. will remain roughly the same if steel be used in place of copper, with the exception of column 7, giving the sectional areas, and column 8, the number of ampères per square inch.

Also all the columns will remain unaltered as long as $\frac{i \times c}{p}$ is constant; for example, no change will be necessary if the yearly interest, including depreciation, be taken as £10, instead of £15, and if the yearly value of an electric horse-power be also taken as £10 instead of £15.

VII.—We may take as an example of the use of the results obtained by this investigation the case of the electric transmission of power from Paris to Creil by M. Deprez. The distance was 37½ miles, and as a wire was used for both the going and return conductors, n equals 75; the potential difference at the dynamo (V) was about 5,600 volts, therefore

$$\tan. \phi = \frac{n \, t}{\text{V}}$$

$$= 0·2278,$$

$$\text{or } \phi = 12° \, 50'.$$

Hence, as the power furnished at the distant end of the line (P) was about 30,000 watts,

$$\text{C} = 6·549 \text{ ampères,}$$

$$\text{and } r = 2·073 \text{ ohms.}$$

give the values of the current and the resistance per mile of the line that should be used to give maximum economy; or, since the line is 75 miles long, the total resistance should equal 155·5 ohms.

M. Deprez actually used a current of about 7·2 ampères, and the total resistance of his line was 100 ohms. We do not know on what principle he calculated the size to give to his conductor, which was a copper wire 5 millimetres in diameter, but the current conveyed was at the rate of about 36·6 ampères per square centimetre. The above, however, shows that the most economical current, using 17 for the value of t, would have been at the rate of 47·7 ampères per square centimetre. But as his object was rather to show economy in electric transmission of power, irrespective of first cost, than to show economy in copper used, and as when he began his experiments he was probably not quite sure of the potential difference at which his dynamo would give out electric power, we think that he was quite right in using a thicker conductor than our calculation shows would have produced the minimum total waste.

We have already seen that when we have to supply a given amount of electric power at the end of a certain line, using a given potential difference at the dynamo, the current density to be employed to obtain maximum economy diminishes as the length of the line increases. Thomson's rule for the current density is obtained from his equation for maximum economy—

$$\text{C} = \frac{t}{r},$$

and the equation

$$\text{A} = \frac{0·04378}{r}$$

$$\therefore \text{D} = \frac{t}{0·04378},$$

which is independent of the length of the line.

For t equal to 17 his D equals about 393 ampères per square inch. We see, therefore, that this current density exceeds that given for all the lengths of line, even for the shortest—0·1 mile or 170 yards—in column 8 of Table I., although in calculating this table the same value was employed for t; that is, the same values were used for the yearly rate of interest, for the price of copper wire per ton, with its necessary insulation, and the same cost per year for an electric horse-power for the number of hours power is required. In order to see whether for any distance, or for any amount of electric power to be supplied at the end of this distance, it is economical to use so large a current density as is given by Thomson's rule, we will find an expression for our current density. Dividing the expression given for C in (13) by that for A in (15), we have

$$\text{D} = \frac{\text{V}}{0·04378 \, n} \cdot \frac{\sin. \phi}{(1 + \sin. \phi)};$$

hence, as

$$\tan. \phi = \frac{n \, t}{\text{V}},$$

$$\text{D} = \frac{\text{V}}{0·04378} \cdot \frac{t}{n \, t + \sqrt{n^2 \, t^2 + \text{V}^2}} \qquad (16)$$

Now this is independent of P, the number of watts to be supplied at the end of the line; hence all the values of D, in column 8, Table I., being smaller than the current density given by Thomson's formula for maximum economy has nothing to do with the amount of power that is to be supplied. Further, we see that the value of D in (16) can only equal $\frac{t}{0·04378}$, the value of D given above by Thomson's formula, when either V is extremely large or n extremely small. Hence we may conclude that in all problems connected with the electric transmission of power where the maximum potential difference that we may use is fixed for us by the Board of Trade, or otherwise, a smaller current density than that given by Thomson's formula must be used to obtain maximum economy, and the longer the line the smaller must this current density be; also, the smaller the maximum potential difference that may be employed, the smaller must the current density be to obtain maximum economy.

VIII.—We have discussed at some length the conditions of maximum economy when a given amount of power has to be supplied at a given distance with a given potential difference at the dynamo, on account of its wide practical importance; but there are many other practical cases which we have not thought it necessary to discuss in which there is an initial relation connecting C and r. One example may, however, be referred to.

Let there be a level electric railway extending n miles in one direction from the engine house, on which one train is running requiring P watts to propel it at a uniform speed of v miles per hour. Let the resistance of the conductor conveying the power from the dynamo to the train be r ohms per mile, and let V be the constant potential difference at the dynamo. At a time (τ)

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reckoned from the time the train is at the engine house let it be at a distance x miles along the line, then

$$P = C(V - C x r),$$

$$x = v\tau,$$

$$dx = v\,d\tau.$$

When the train is at a distance x the rate of wasting power, in watts, is

$$C^2 x r + n\frac{t^2}{r};$$

therefore the waste, in joules, in a time $d\tau$ is

$$\left(C^2 x r + n\frac{t^2}{r}\right) d\tau;$$

hence the loss in the whole line n miles long is

$$\frac{1}{v}\int_0^n \left(C^2 x r + n\frac{t^2}{r}\right) dx,$$

and maximum economy will be effected by selecting C and r so that this expression is a minimum when C and r are connected by the first equation given above.

IX.—Hitherto we have been dealing with a conductor giving off power only at one point—either at its end, or, as in the last problem, at a point the position of which varies from time to time; but in telpherage, and in many systems of electric lighting and transmission of power, we have to deal with a conductor giving off in every mile the same amount of electric energy, which, bear in mind, does not mean giving off the same amount of current per mile, since there is a diminishing potential difference as we proceed along the conductor from the dynamo. This problem we deal more fully with in another paper. But if we suppose that an independent conductor takes the required supply of energy to every short length of line—that is, if a number of feeders are employed—we can at once use the results that we have already obtained to determine the most economical amount of copper to employ.

Having determined the most economical size of separate conductor to convey the power to each point of the line of distribution, we may for practical purposes imagine all the conductors connected together metallically so as to form a tapered conductor. As, however—if we imagine such a metallic joining together of the separate conductors—currents will flow through the connections, because the potentials at a point where a connection is going to be made differ from one another in the various conductors, it follows that a conductor of the aggregate section of all the small conductors at every place will not be as economical as would be a conductor whose section at every place was independently determined from the considerations which are given by us in our other paper. However, taking the section of the tapered conductor to be equal to the sum of the sections of the separate conductors which distribute the energy with maximum economy, we find that the following is the result:—

Let the section of a conductor to transmit with maximum economy P watts n miles with a given potential difference be called

$$P f(n);$$

then

$$\int_x^{x_1} P f(x)\, dx$$

is the aggregate section at a point x miles from the dynamo when the end of the line is x_1 miles from the dynamo. It is easy to obtain an exact integral, using (15) for $P f(x)$, but we have preferred to integrate from a curve giving the value of A or $P f(x)$ when P is 20,000 in column 7 of Table I.

In this way we have, for the purpose of illustration, calculated Table II., which gives the most economical sectional area, in square inches, at the end of each mile when the conductor *tapers* according to the law just mentioned; it is calculated for a potential difference of 200 volts at the engine house, and for a power of 5,000 watts given off in every mile. The four horizontal rows give the sectional area, in square inches, of the tapered conductor at the end of each mile, when the total length of the conductor is respectively 3, 5, 8, and 10 miles.

TABLE II.

Total length of conductor from engine house, in miles.	Area, in square inches, of the tapering conductor at the end of										
	0	1	2	3	4	5	6	7	8	9	10 miles.
3	0·24	0·17	0·09	0							
5	0·47	0·40	0·32	0·23	0·12	0					
8	0·94	0·88	0·79	0·70	0·60	0·47	0·33	0·18	0		
10	1·35	1·28	1·20	1·11	1·00	0·88	0·74	0·58	0·41	0·21	0

Table III. gives the current, in ampères, flowing through the conductor at the end of each mile in each of the various cases described above.

TABLE III.

Total length of conductor from engine house, in miles.	Current, in ampères, flowing through the tapering conductor at the end of										
	0	1	2	3	4	5	6	7	8	9	10 miles.
3	85·7	59·6	31·4	0							
5	151·8	125·7	97·5	66·1	34·0	0					
8	262·9	236·8	208·6	177·2	145·1	111·1	75·5	38·4	0		
10	343·2	317·1	288·9	257·5	225·4	191·4	155·8	118·7	80·3	40·7	0

Table IV. gives the current density at the end of each mile in each of the cases described above.

TABLE IV.

Total length of conductor from engine house, in miles.	Current density in the tapering conductor at the end of										
	0	1	2	3	4	5	6	7	8	9	10 miles.
3	357·2	350·5	348·9	0							
5	322·9	314·2	304·7	287·4	283·2	0					
8	279·7	269·1	264·1	253·1	241·8	236·3	228·8	213·3	0		
10	254·2	247·7	240·7	232·0	225·4	217·5	210·5	204·6	195·8	193·8	0

Here again, then, the current density proper to be used to obtain maximum economy is not constant. It not only diminishes as we go further along the tapered conductor, but at any one point is the less the greater the total length of the line.

In the discussion which followed the reading of the paper,

Prof. G. FORBES considered that the paper just read had materially advanced our knowledge of the subject. He protested, however, against the way in which Sir William Thomson's law had been referred to; the latter had not, he thought, been fairly dealt with. The law as originally stated dealt with a particular case, and the law as laid down by Professors Ayrton and Perry was a modification of the same for a particular stated condition, and it could not be considered as a correction of Thomson's law. There were a great many points which require to be taken into consideration in working out the general problem of the calculation of mains. He would point out that the cost of laying down the mains, *i.e.*, opening out trenches, filling in, &c., did not vary directly as the sectional area of the conductor. The size and cost of the dynamo was an item which did not come as a direct varying quantity. The problem dealt with by Sir William Thomson was totally different from that dealt with by the authors. With reference to the Table given he would point out that the great variation in the quantity, t, which would be met with in practice rendered the table of comparatively little value. He would state that it was a mistake to suppose that the Board of Trade limited the difference of potential to be used on the line of route, it was only in the houses that this limit was imposed.

Mr. R. E. CROMPTON drew attention to a numerical error in the early part of the paper, the value of r being given as ·051 when it should be ·51.

Dr. FLEMING said that in any installation when the number of lamps required was fixed, the maximum current was also fixed so that Thomson's law could be literally applied. In taking the interest according to this law, it was necessary not only to consider the cost of the conductor pure and simple, but also the cost of opening out and filling in the trenches, &c.

Prof. AYRTON pointed out that Mr. Crompton was mistaken in imagining that there was any numerical error in the paper, and that Mr. Crompton's mistake arose from his not observing that the loss had been calculated *per mile*, not for the whole length of the line. The word "total" used in the paper was perhaps a little misleading, but the "totality" referred to the loss in power from the two causes heating and wasted interest, and not to the loss for the whole line.

Prof. PERRY remarked that, although it was perfectly true that in Sir William Thomson's mathematical paper read at the British Association, he assumed the current fixed and said nothing about the potential difference at either end of the line, in Sir William Thomson's inaugural address where he used his own law for the electric transmission of power from Niagara, he started by assuming that the potential difference at the dynamo was 80,000 volts, and he also assumed that the potential difference at the far end of the line was also fixed. Now under those circumstances the law given by Sir William Thomson did not lead to maximum economy as was supposed.

A paper was next read by Professors Ayrton and Perry on "Some Problems in Telpherage." The authors showed mathematically the conditions necessary to ensure a uniform supply of power per mile on a telpher line of various lengths.

The meeting then adjourned.

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Royal Society.

"Effects of Stress and Magnetisation on the Thermoelectric Quality of Iron." By Professor J. A. EWING, B.Sc., University College, Dundee. Communicated by Sir William Thomson, F.R.S. Received February 24th, 1886. (Abstract.) Read March 11th, 1886.

This paper comprises a revised version of one submitted to the Royal Society in 1881, under the title "Effects of Stress on the Thermoelectric Quality of Metals, Part I.," * along with much new matter. It deals principally with the cyclic changes of thermoelectric quality which an iron wire undergoes when exposed to cyclic variations of stress (described in the abstract of the former paper), and with the relations of these changes of thermoelectric quality to the changes of magnetism which also occur as an effect of stress. Stress was applied by exposing the wire to longitudinal pull by means of loads. The changes both of thermoelectric quality and of magnetism exhibit that tendency to lag behind the changes of stress to which in a previous paper † the author gave the name *hysteresis*, and the effects are sufficiently similar in regard to the two qualities to suggest that the changes of thermoelectric quality occur as secondary effects of changes of magnetism. To examine whether this is the case, simultaneous measurements of the magnetic and thermoelectric effects of stress in an iron wire were made, and also independent observations of the thermoelectric effects of magnetisation, without change of stress. A comparison of these made it clear that stress causes change in the thermoelectric quality of iron directly, and not as a secondary effect of magnetisation. If the wire be completely demagnetised to begin with, and kept clear of all magnetisation during the application and removal of stress, the presence of hysteresis is not less marked than before. Experiments are given to show how the thermoelectric effects of stress are modified by the existence of more or less magnetisation in the wire; and conversely, how the thermoelectric effects of magnetism are modified by the existence of more or less constant stress. The influence of vibration in destroying the effects of hysteresis is investigated, and also the result of exposing the wire to the process of demagnetising by repeated rapid reversals of a continuously diminishing magnetising force, and it is shown that this process acts in the same way as vibration in destroying the effects of hysteresis. Residual effects of hysteresis are studied, as, for example, the difference which presents itself when a wire is magnetised after having been loaded strongly and then unloaded down to a certain constant state of stress, and, on the other hand, when the same state of stress has been produced by simply increasing the load; and it is shown that these residual effects are wiped out by vibration or by demagnetising by reversals. With regard to the effects of stress on thermo-electric quality, it is shown that if a somewhat soft wire be more and more strongly magnetised, these effects become more and more similar to those which are found when the wire is hard-drawn, but not magnetised. A few experiments were made with wires of silver, copper, lead, magnesium, and German silver, but in none of these was hysteresis of thermoelectric quality with regard to load discovered.

Special attention is directed to a peculiar feature in the curves by means of which the experimental results are exhibited. In curves showing the relation of thermo-electric electromotive force to load, it is shown that any reversal from loading to unloading, or *vice versâ*, causes an inflection in the curve, the first effect of the new process being to continue the kind of change of thermoelectric quality that was going on before. That this is not due to any mechanical disturbance which the loading or unloading produces, is shown by the fact that it occurs in an equally marked way after the molecules have been brought to a condition of stable equilibrium by vibrating the wire before beginning to load or unload. It is suggested that the effects of hysteresis, described in the paper, have a possible relation to the properties which Prof. Osborne Reynolds has recently shown to be possessed by granular media.

The experiments described in the paper are closely connected with those which were communicated to the Society in January, 1885, under the title "Experimental Researches in Magnetism," and are now being published in the *Philosophical Transactions*. They were conducted in the Physical Laboratory of the University of Tokio, in 1881-3, partly with the help of one of the author's Japanese students, Mr. S. Sakai. The results are given graphically, and are for the most part reduced to absolute measure.

NEW PATENTS—1886.

3360. "Electric alarm clock." J. WARMISHAM. Dated March 10.

3418. "Protecting or insulating wires used for conducting electric currents." M. SETTLE. Dated March 11.

3448. "Method of shot-firing and blasting in mines by the agency of electricity." F. BRAIN. Dated March 11.

3475. "Dynamo-electric machines." R. E. B. CROMPTON. Dated March 11.

3476. "Galvanic batteries." A. SCHANSCHIEFF, G. R. FLUDDER. Dated March 11.

3499. "Small-sized switches to be used in electric lighting circuits." G. LOWDON. Dated March 12.

3508. "Electric light fittings." R. E. B. CROMPTON, W. A. KYLE. Dated March 12.

3516. "Holders or supports for incandescent electric lamps." A. SWAN. Dated March 12.

3535. "Acoustic telephones." H. G. ELLERY, J. T. GENT. Dated March 12.

3554. "Dynamo-electric machines." W. HARTNELL. Dated March 13.

3556. "Making sugar by electrolysis. E. FAHRIG. Dated March 13.

3568. "Induction cables." A. VOGT. Dated March 13.

3577. "Depolarising electric batteries." A. C. HENDERSON. (Communicated by E. Bazin.) Dated March 13.

3587. "Vibrating electric motors." A. L. PARCELLE. Dated August 11, 1885. (*Complete.*)

3598. "Electrical switches." H. W. EDLIN. Dated March 13.

3540. "Electric fuse for blasting purposes." A. M. CLARK. (Communicated by Scola et Ruggieri.) Dated March 12.

3605. "Means or apparatus for producing and regulating or controlling electric currents." J. Y. JOHNSON. (Communicated by E. A. G. Street and A. L. W. Desruelles.) Dated March 13.

3657. "Electric incandescent lamps." E. EDWARDS. (Communicated by E. Herrmann.) Dated March 15.

3670. "Electric incubator and foster-mother." H. NEUMANN. Dated March 16. (*Complete.*)

3726. "Galvanic batteries." H. H. LAKE. (Communicated by J. Serson.) Dated March 16. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

992. "Improvements in electrical motors." R. A. LEE and J. E. CHASTER. Dated January 23. 8d. Consists generally in constructing the revolving armature of considerable diameter in proportion to its width, in combination with improved field-magnets. The armature is a ring form made in the softest iron. It is divided into six or more equal divisions, which divisions are parallel in themselves, and at right angles to the centre of motion, and upon which the necessary wire is wrapped. One of the several features is, that the divisions that are opposite have parallel sides, that is the outside and inside edge of the ring are parallel with themselves, and likewise parallel to the two sides of the division opposite, thus allowing the wire that is wrapped thereon to be very evenly laid coil upon coil. The coils of wire on each section are also stepped off each other, so that a considerable air space is left between one section of wire and its neighbour, thus allowing a free ventilation, which prevents the motor from becoming heated.

2833. "New or improved applications of electro-magnetism to arm chairs, seats, carpets, or other articles of furniture to produce a magnetic bath or medium." W. L. WISE. (Communicated from abroad by G. Edard, of Paris.) Dated March 3. 8d. Has reference to the application of electro-magnetism to carpets, armchairs, beds, couches, seats or other articles of furniture for subjecting sick persons to the influence of a magnetic medium, the composing elements of which are excited by the passage of a current proceeding from a generator of electricity of any suitable nature.

2896. "Dynamo-electric horse clipper." C. DE SALAZAR. Dated March 5. 8d. Consists of fixing to ordinary horse clippers or others of more suitable size, between the handle and the scissors two induction rings with electric motor, this new disposition allows also for diminishing the weight and size of the clipper. The circular rotary movement caused by the electric motor is transformed into and gives to the scissors an alternating rectilinear motion by a system of articulating levers which diminish and regulate the speed of the motor and scissors which otherwise would be too great, and this also allows for considerable increase of power in the clipper. This motor can be kept in action by any ordinary electric battery, which may be attached to or carried by the person using the clipper.

3888. "Improvements in the manufacture of electrical batteries." L. P. MERRIAM. Dated March 26. 4d. Consists in forming the joints of the troughs by means of xylonite or other pyroxylin compound which is not affected by ordinary battery solutions or liquids.

14891. "Improvements in the transmitting of Farquharson and Lane's electric ship's telegraph." W. SKINNER, J. FARQUHARSON, and D. W. LANE. Dated December 4. 6d. Consists generally of a method of utilising stored energy for actuating the mechanism of the transmitting instrument at a uniform rate and at the maximum speed which can be utilised in the recording or receiving instrument by which means an important advantage is gained as the sender of the signal is free to attend to other matters while the signal is being transmitted.

* Published in abstract in *Proc. Roy. Soc.*, No. 214, 1881.
† *Proc. Roy. Soc.*, No. 216, 1881, p. 22.

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CORRESPONDENCE.

Secondary Batteries as Regulators.

Since writing last week, I have thought it not out of place to add a few words to show the relation which exists between the cells and line when charging. In doing this it is not my intention to give remedies, or to investigate some other points which might enter upon the question. My object is merely to give the relation, and to show that true regulation cannot exist, although it may be an approximation if well adjusted.

Let the resistance of the line be n times that of the cells. Then all variable current, *i.e.*, current above the normal due to variation in speed or from other causes; will divide between cells and line as $1 : n + 1$ and $\therefore \frac{1}{n+1}$ of all such variable current will go to line, and, consequently, the variable E.M.F. altering in this proportion. Clearly when n is large the regulation will be good, for $\frac{1}{n+1}$ will be small, for it must be assumed that the variations at the terminals of the dynamo will not be large, say 2 per cent. to 5 per cent., at most. Now, as n gets smaller the regulation gets worse.

In other words, the more lamps turned on the worse will be the regulation.

Again, the *curve* of a shunt machine is a falling one, so that when few lamps are in use they will be rather brighter than when many are on (this is the case whether *cells* are used or not, and can easily be shown theoretically, as well as practically), and if the light given by a lamp varies as $K\ C^6$, where K = a constant and C = the current, it is clear that pulsations in the light will be greater as the number of lamps are increased.

Now, when a lamp is bright, and becomes brighter, the difference is less perceived by the eye than when less bright and it becomes brighter. From this cause arises the difficulty of using the eye as a photometer for bright lights. Hence two things combine to give unsteadiness to the light when the number of lamps in use are continually increased in number. Firstly, $\frac{1}{n+1}$ gets smaller; secondly, the light pulsations are greater; and thirdly, the E.M.F. of the lamp circuit is lower, and in consequence the variations become still more marked to the eye. These remarks practically cover the ground. To assist "installators" in putting this to the test, it may be assumed that a 50 cell battery of 12-plate E.P.S. cells, with leads and connections, has a total resistance of 0·3 ohm, for with 10 per cent. E.M.F. above the counter E.M.F. of the battery 30 ampères pass. Values for n can always be found by taking a series of cases in which a given number of lamps are alight. The variations of E.M.F. can then be calculated and connected with the *curve* of the dynamo. If this latter is a good one, the *curve* will be practically a straight line within the capacity of the installation, and no further correction will be needed.

David Salomons.

Broomhill, Tunbridge Wells,
March 15*th*, 1886.

Dolbear and the Telephone.

Prof. Dolbear's analysis of existing telephone systems in your issues of February 12th and 19th is both clear and to the point. Mr. A. R. Bennett's letter of 5th inst., showing that he was independently at work on two receivers mentioned by Dolbear, has induced us to make public our claim also to having designed a battery transmitter, which we thought at the time was entirely new. Under the heading of "Dolbear's System, No. 1," the professor describes a battery transmitter which serves the double function of generator and controller of the electric current. An identically similar instrument to this we made in the early part of last year, with the exception that ours appears to have been larger than his. Though our cell was made as thin as possible, with the double object of gaining any advantage there might be by vertical as well as horizontal displacement of the liquid by the vibration of the diaphragm-element, thereby reducing and increasing the resistance two-fold, it was not so successful as we had expected. The professor does not seem to have been quite satisfied with its transmitting powers, for, referring to the distinctness in the receiver, he says, it was "*nearly* sufficient for every one"—an expression which is somewhat vague. We used a thin iron plate as vibrating element and a solid zinc plate as the other element, with a solution of caustic potash, choosing this excitant on account of its not attacking the iron. Our experiments with this instrument gave some very curious and unexpected results, and eventually led us to considerably modify its construction; and we are now, we believe, in possession of a novel and completely different instrument, particulars of which we hope shortly to be in a position to make public.

Coates and Macdonald.

Bow Electric Works, Bow, E.,
March 11*th*, 1886.

The General Distribution of Electricity by Continuous Current Transformers.

From the results of the remarkable experiments recently conducted on the Edison-Hopkinson dynamos, and which you described in your last issue, I should like to suggest that we have the password to an almost direct, continuous current distribution system. Let us suppose a high potential generator outside a supplied area, which is divided into a number of smaller districts, and that in the circuit of the generator are a number of motors in series with one another, a motor being in each district, and driving a corresponding but low potential generator which supplies a working current to the district. Each of these district motors and generators must be capable of supplying a constant potential with a varying consumption in its own district, and of not being affected by, or affecting the potential of, any of the other districts. This may be attained by governing the high potential generator to maintain an absolutely constant current in the motor circuit, so that the armature of each motor in the series will always have the same number of ampères passing through it, whether the other motors are running or not, and whether their counter E.M.Fs. are great or low, thus rendering each district entirely independent of the others. The speed, however, of each motor has still to be regulated to drive its generator, so as to maintain in its district a constant potential with varying consumption. This might, perhaps, be accomplished by winding the generator for constant potential with constant speed, and the motor for constant speed with constant current; but as the motor and generator would be running at the same speed for one lamp as for 1,000, and as I do not know that the dynamo will at present regulate itself sufficiently with such different loads, I prefer to use simple shunt-wound motors and generators, and to regulate the speed of the motor by varying its magnetism. Suppose the full current to be passing through the motor armature, if the magnets are inert no movement of the armature will take place, if feebly magnetised there will be a corresponding movement of the armature, the power and speed increasing as the magnetism increases. The magnetism may be varied by means of a variable resistance in the shunt, and controlled by an electric governor influenced by the potential in the mains of the district. So that thus each district automatically maintains its motor only at that speed that is exactly suited to its immediate rate of consumption; the main generator automatically accommodating itself to the amount of power and light required in the whole system.

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It is evident that the same method of distribution and of regulating the motor is applicable to electric rail and tramways. If the power supply, such as a waterfall or tidemill, is a great distance from the town or supplied area, the high potential current might be transmitted by relays, or a chain of coupled motors and generators, and when we have arrived at the use of very high potentials, and but a little more efficiency in the dynamo, with little loss on the way.

G. E. Dorman.

Stafford, *March 14th*, 1886.

Secondary Battery Indicators.

I have carefully read Mr. Sellon's specification as given in his letter in your last issue, and must say, with all due deference to that gentleman's valuable invention, that I fail to see how it anticipates the perfected arrangement patented by Mr. Parker in 1884.

In the first place, ascertaining the state of the charge in the secondary cell by measuring the specific gravity of the liquid had, we all know, been suggested and practised before the date of Mr. Sellon's patent.

In the second place, the designs shown in figs. 1 and 2, and fully described by Mr. Kent, *would not work*, because *any change* in the density of the liquid, sufficient to cause the bulb to move *at all*, would send it right to the top or the bottom—whichever it happened to be—as there is nothing to stop it, unless the "*fine* wire of glass or of platinum" is supposed to displace so much of the solution that it would act like an ordinary hydrometer. If the latter be the case, then the accuracy of the measurements indicated must depend upon the liquid being maintained always at an exact level in the cell, and I do not think there are many "gardeners" who could be depended upon to keep this level always constant.

Mr. Sellon's arrangement, shown in figs. 3 and 4, also depends entirely upon the level of the solution in the cell, and I feel sure the "gardener" would be too "heavy handed" to adjust this always—even to one point of decimals—and a variation of one-tenth of an inch might cause much over charging.

Mr. Parker's claim is for a simple form of hydrometer, which is not influenced by changes in the level of the liquid in the cell, and correctly indicates the density, so long as the bulb (which is of considerable size in order to make the indications very accurate) is entirely below the surface of the solution. The weight is increased or diminished as the arm carrying the balance weight forms a more or less acute angle with the perpendicular.

Mr. Sellon could obtain a similar, but I think a less accurate effect (owing to friction, &c.), by using what is called a fusee, instead of the pulley in his "wheel barometer" arrangement; but this would make it practically the same as what Mr. Parker claims.

P. Bedford Elwell.

March 16th, 1886.

The Meaning of Diaphragm.

"Telephonist" says that all the telephonic conferences in the world cannot alter the patent laws or limit the meaning of that wonderfully *flexible* and *elastic* word "diaphragm." How admirably put! But they can—or rather, common sense and judicial impartiality can—prevent that flexible and elastic article the "diaphragm" from being so distorted as to include things that are neither flexible nor elastic, and which, therefore, cannot be what Edison says his diaphragm must be, namely, of mica or other flexible material. The inventor never used or intended to claim anything more than that.

"Telephonist" is quite right: flexible and elastic.

"Inflexible."

London, *16th March*, 1886.

Dynamo Testing.

The method of testing dynamos used by Captain Cardew seems to me to be the best yet introduced; but would it not be a more perfect test if the belt were dispensed with, and if the shafts of the two machines were coupled together as in Dr. Hopkinson's method? By this means there would be no unknown loss in the transmission of power from the motor to the generator.

The percentage of error in the test, due to the dynamometer used in measuring the energy supplied to the machines, has been greatly reduced by Dr. Hopkinson's arrangement; but I think this might be altogether avoided by using a current from another machine, or from secondary batteries, as suggested by Lord Rayleigh, to supply the extra power required.

W. E. Hayne.

March 16th.

Telephone Conference.

Because Mr. Irish made the proposition for a telephone conference, I do not think he deserves the onslaught of "Telephonist" in his letter to you, for it is notorious that there has long been a strong desire amongst electrical firms to wrench the monopoly from the hands of the one company now holding it. There is no chance to "run" anybody's telephonic patents in Great Britain without a very clear common-sense, as well as legal opinion, as to its being clear of the Bell and Blake patents, so that Mr. Irish's patents would, like other inventors', stand on their own merits. I think a conference of inventors and electricians would be of use, and, for one, would willingly take part in one within easy reach. Such a conference to discuss points, and exchange ideas for mutual benefit, and for testing suggested experiments, would I believe be of value. True, the Bell and Blake patents have only a few years to run, yet to get into the market before that for private work, if not for exchanges, is what is wanted, to say nothing of aiming at

Long-distance Telephony.

Charge and Discharge Indicators for Secondary Batteries.

Unless it be too early—with an experience of something less than a year—to offer an opinion on the behaviour of secondary batteries, I would venture to say, with reference to the present discussion in your columns, that, as an index of charge, the voltmeter is far preferable to the hydrometer.

The storage cells I use, are (like the dynamo) by Messrs. Elwell-Parker; and for the first few months their condition was estimated principally by the variation in specific gravity, checked by occasional observations with a two-coil "detector galvanometer." Tests were taken (1) by two instruments of the hydrometer-index pattern (illustrated at page 205 of the ELECTRICAL REVIEW for March 5th) permanently fixed over two separate cells. (2.) By a hydrometer specially made, of long scale, and thin enough to pass in any cell between the ends of two adjoining plates. (3.) By filling a pint jar with liquid drawn from various depths of the cell by a large glass syringe with long nozzle, and using a sensitive hydrometer. But the results were discordant, and sometimes contradictory. The reason probably is, that the change in specific gravity does not proceed uniformly throughout the cell: and that it is not practicable, without removing the plates, to agitate the liquid thoroughly, with a view to its examination by the hydrometer. Perhaps, too, the observations are vitiated by the addition, from time to time, of plain water to the cells, to replace what is lost by evaporation, or by the generation of gas. Moreover, the extent of variation in sp. g. is very slight, seldom more than 5° (*e.g.*, 1,125 before charging, and 1,130 after.)

In the exhaustive paper by Mr. Preece, F.R.S., published in the ELECTRICAL REVIEW, of May 28th, 1885,

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it is graphically shown how the progress of the charge of secondary batteries can be tested not only by the hydrometer, but by the alteration (the dynamo remaining constant in speed) of both current and E.M.F.—and, for my own part, I find this last to be all that is required. The gradual rise of E.M.F. during charging seems to be an unfailing indication of increased storage: at any rate, when a certain reading of the voltmeter (determined by previous trials) has been attained, no further efforts of the dynamo can augment it; and it is therefore fair to assume that this maximum E.M.F. corresponds to a full charge of the battery. For instance, the following is one of the entries for an afternoon's run. The attendant at the dynamo takes frequent readings of a voltmeter and ammeter in the same room with the machine, recording them every half-hour, and more frequently when the charge is supposed to be nearly complete:—

H. M.	Revolutions.	Volts.	Ampères.
1 15	950	58	54
1 45	975	60	58
2 15	975	62	58
2 45	980	63	58
3 15	980	65	58
3 45	980	66	59
4 15	1000	67	59
4 35	1000	67	57

Previous experience had fully proved that when, as in this case, 25 cells were being charged, 67 volts is the maximum E.M.F. obtainable at about 1,000 revs. of the dynamo: consequently, when this reading has been repeated and maintained, the dynamo is always stopped.

Certainly, if hydrometric indications were reliable, they would afford a convenient estimate of the gradual *discharge* of a battery: but for this purpose, I find one of Mr. Ferranti's ingenious meters to give more accurate information, and without the trouble of seeking it in the battery room. The revolutions of the meter for a given period, when divided by its constant, are equivalent to the ampère hours discharged during that interval of time. And, on the other hand, to ascertain the number of ampère hours *put into* the battery on any occasion, it is only necessary (in the absence of a second meter, on the charging circuit) to take the average current for the specific time. For instance, in the above example, the supply from the dynamo may be taken at 57·5 ampères for 3·3 hours, or 190 ampère hours. Then, allowing a margin of rather over 10 per cent. of current (of course the loss in Watts is greater) it is a simple matter of subtraction to decide how many ampère hours should be available from the battery at any time. Practically, even that calculation is not needed, so long as the light required from the battery remains about the same, and, if the storage should be greater than it is supposed to be—and charging be resumed too soon—the voltmeter will soon reveal the state of affairs, and will tell the attendant that he may stop the dynamo sooner than he expected.

Thomas S. Bazley.

Athenæum Club, Pall Mall,
March 13*th*, 1886.

Mechanical Telephones.

Not much harm is done by the registration of the Mechanical Telephone Company with its very modest capital, and I believe it has a better chance of earning a dividend than many of the highly-vaunted electrical ventures of 1882-83. The absence of a cheap telephone worked by electricity has created a demand for mechanical ones for short distances. Whether the new firm can persuade the public to buy their particular articles is a matter for themselves. As yet I have not seen any prospectus; but it is evident, on the face of it, no large sums can be paid for the two patents of "Byng" and "Lee." Payment by results would appear to be the wisest arrangement. As it is, "Telephonist" may not have the opportunity of subscribing to the £5,000 of capital, which he hopes you will warn all and sundry against ruining themselves by.

Acoustic.

Telephone Patents.

I am somewhat amused at the marked desire of your correspondents to put me right upon my supposed want of information as to the action of the Valve transmitter, which somehow they fancy I cannot believe can possibly work without a diaphragm.

Mr. Sidney F. Walker (whom I was nearly referring to as Mr. *Duplex* Walker, seeing he speaks of "our," "I," "my," and "we,") after his little bit of instructive information goes at once to the question of the working of the New Telephone Co.'s instruments, and as he has the reputation of being a practical electrician, his remarks should carry due weight and authority. Let us see how far his testimony accords with my previous letter. He says that his "experience with the same company's instruments has not been very fortunate," and gives his idea of the cause of these negatively stated bad results as "due to bad workmanship in the manufacture." That being so, I say, is but in strong support of the facts set forth by me in my previous letter, which despite of Mr. Secretary Barnard's attempted sneer, *were not* "*imaginative*" *statements but facts*, drawn forth by his rushing in to chide me for not making mention of, or rather ignoring the existence of, the New Telephone Company's telephones. He claimed for them a value which, when fitted up by their own representatives, they had not been able to make the instruments exhibit; and I but recited my experience, which had practical results in the loss to them of a good order, with more in prospect. It is most singular to note that whilst Mr. Barnard refers to a list of testimonials, that in the case of Mr. Walker and the one I referred to, the inspectors sent down were unable to make the instruments work properly; for if you place a good instrument into incompetent hands it might fail, indeed, the probability is that it would; but a badly-made article was rendered less efficient by clumsy handling, so that whilst Mr. Walker closes by saying he believes the instrument is a good one, his letter convicts them of bad workmanship and inefficient inspectors.

The gratuitous advertisement sought for and obtained by Messrs. Jno. Barrett & Bros. takes off somewhat from the value of their testimony, whilst the information that the line was erected before the instruments were tried will be smiled at for its originality.

If "Telephonist" will re-read my letter, he will see I did not blame the transmitter. I gave results from the set of instruments, and wanted to know *where* the cause lay of only getting Punch and Judy talk.

When first I wrote you I had no idea the discussion would have drifted as it has done, thanks to Mr. Barnard. Next week I may endeavour to bring back into its proper channel the question started by

"Combination."

"Self-Induction."

What—in the name of all the mysteries to be revealed through an attentive study of the phenomena presented by helical conductors—does "A Coil" mean by saying that "Prof. Fitzgerald," in the discussion upon Prof. Hughes's paper, "proved the existence of magnetism before it was born"? As only one person of that name spoke during the discussion in question, the individual referred to must be your humble servant. But, on a careful perusal of the notes, taken by the shorthand writer, of what I did say, I fail to find anything that could have inspired the above view. And, if the latter be a joke, I fail also to see the point of it. Perhaps that may be because what is "writ so sarkastic"

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here applies to myself; for I can not only understand but to a great extent sympathise with the main purpose which underlies your correspondent's letter.

Perhaps what he means to say is that I proved the existence of a maximum of magnetisation in the conductor prior to the passage of the normal current, and of *some degree* of magnetisation prior to the passage of *any* current. In this case—to use the expression of "My little Sweetheart's" favoured suitor—he *flattens* me! I did not prove it; but I suggested it. There was no time at my disposal to prove anything, without preventing other speakers from having their say. But with your permission, Mr. Editor, I will send you a paper embodying what I meant to say, and what probably I should have said, had the occasion been more favourable. I may assure "A Coil" that my communication will have the negative merit of containing no complicated formulæ.

Desmond G. FitzGerald.

Every listener present at the discussion which followed Prof. Hughes's most excellent paper cannot have been quite so ignorant as your correspondent "A Coil," who declares that "one and all" of the "professors" who took part in the discussion made the coefficient of self-induction "*in a coil*" the burden of their song. I was present at the whole of the debate, and heard the following professors speak, viz.:—Lord Rayleigh, G. Forbes, J. Hopkinson, J. A. Fleming, S. P. Thompson, and W. E. Ayrton, and, unless I am very greatly mistaken, they "each and all," when speaking of the coefficient of self-induction, dealt with it not in relation to coils at all, but in relation to circuits in general, and particularly in relation to straight conductors such as Prof. Hughes had been using. The algebraic expression which Lord Rayleigh wrote upon the black board (and which, because it was quoted from Maxwell's treatise, seems to have excited a current of self-induced anger in "A Coil"), was an expression for the self-induction of a circuit consisting of *two parallel straight* wires, and was stated in terms of their length, thickness, and distance apart! Probably it is, to a person so devoid of a knowledge of simple algebra as "A Coil," an easier matter to copy out of Wiedemann's treatise a complex formula relating to something that never came into discussion than to understand the very simple formula for straight conductors which Lord Rayleigh set before him; he didn't even take the pains to notice that it was a formula for straight conductors and not for coils. No wonder he didn't grasp Lord Rayleigh's other point that "the self-induction" in a circuit was a different quantity from "the coefficient of self-induction" of that circuit. Perhaps "A Coil" is not aware that "the magnetism" in a bar of iron is a different quantity from "the coefficient of magnetisation" of that bar. Perhaps "A Coil" would be surprised to learn that "the interest" which he may receive on a sum deposited is a different quantity from "the rate of interest" by which the amount is calculated. But as his mathematical abilities are of so mean an order as to preclude him from understanding even what Lord Rayleigh's elementary algebra related to, it is probably useless to explain to him the point that is vital to the understanding of everyone of the experimental results obtained in Prof. Hughes's research.

"A Coil" says, quite truly, that "the President in his paper never attempted to prove the coefficient of self-induction in a coil;" the only allusion to the coefficient of self-induction in a coil is due to "A Coil" himself. "Here's a coil," indeed! If "A Coil" will but shuffle off his tortuosity and become a straight conductor he may perhaps be induced (mutually induced, perhaps, if not self-induced) to join circuit between the experimenters and the mathematicians—between those who dig for treasure and those who analyse the treasures so dug up. But if he would do this, he must have the patience to try to understand what words mean; and when he hears a professor say, "Let l stand for the length of the straight conductor and r for its radius," he must not jump to the conclusion that the professor is talking about "a coil," but must have enough patience to think that the professor really means that the conductor, though straight, can have a radius of its own. If he will think a little more he will then perhaps begin to understand how a straight round wire can have a radius; and then, perhaps, though it is rather a harder task, he may some day grasp the very elementary notion that a straight wire when joined in a circuit may have a coefficient of self-induction too.

A Professor.

Primary Batteries.

Allow me to reply to the paper on a Safety Lamp, read by Mr. Swan at the Glasgow Philosophical Society. Mr. Swan directed attention to the power of the combination of zinc-dilute sulphuric acid, peroxide of lead, as a primary battery, and said that this combination was entirely neglected since it was proposed, forty years ago, by De la Rive.

I tried in 1884 and 1885 different forms of that battery, and obtained results which would perhaps interest your readers.

I made, firstly, a battery with zinc—dilute sulphuric acid—and peroxide of lead—lead. The peroxide was obtained by action of nitric acid on minium, and maintained by means of asbestos. The electromotive force was very low (1 volt), and the cell rapidly polarised. This seems singular; zinc accumulators when charged are quite similarly constituted, and give 2·5 volts. I put then the electrodes of the battery in connection with three Bunsen's cells, as to charge an accumulator, and after a few minutes the electromotive force was 2·4 volts, and remained constant till all the peroxide was reduced. The current was about constant (1 ampère) for plates of 4 inches by 8. In that battery the thickness of the coating of peroxide was about one millimetre.

I made then a cell with zinc—dilute sulphuric acid and peroxide of lead, of the same quality as previously, deposited on a plate of solid carbon, and maintained by means of asbestos; I had immediately an electromotive force of 2·3 volts, but the current was not quite constant, and after having worked some time (two cells on a 4 volts 1·5 ampère lamp) the appearance of the positive plate was very curious. A layer of sulphate of lead, mixed with peroxide of lead, was formed on the exterior surface of the peroxide and also on the carbon plate; the peroxide coating was then quite insulated of the plate and liquid, sulphate of lead being a very bad conducting material. This may be the cause of the inconstancy of the peroxide of lead cells with carbon plates and dilute sulphuric acid.

The production of sulphate of lead on the surface of the peroxide coating, and also on the carbon, is perhaps due to the little conductivity and great porosity of the carbon employed; it would be quite avoided by using another liquid. I tried, without success, chloride of sodium, sal ammoniac, which give sub-products, with the peroxide of lead resulting from the electrical action. Chloride of zinc, only, gave good results; it must be employed in solution at 80 per cent., then no local action is to be feared at rest, resistance is somewhat higher than with dilute sulphuric acid, electromotive force is 1·9 volts, constancy is not absolute, but the depolarisation at rest very rapid.

When we use a zinc—chloride of zinc—peroxide of lead-carbon battery, peroxide of lead obtained by electrical action, electromotive force is 2·1, and current constant.

The preceding results seem to prove that the molecular constitution of the peroxide of lead is an important factor as regards electrical action, and a crystalline form is the best, conductivity and easy decomposition being then very high.

J. W. Dierman.

University of Ghent,
March 8th, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 435.

ECONOMY IN ELECTRICAL CONDUCTORS.*

THE heated discussion which followed the reading of Profs. Ayrton and Perry's valuable paper on electrical conductors clearly showed that on one important subject, at least, the *savants* who listened were not in complete agreement. The rational supposition that there would be found amongst mathematicians but little room for difference of opinion on a subject which admitted of rigorous mathematical treatment, was proved at the meeting of the 11th to be altogether wrong, and the sharp fire maintained between the authors of the paper and their critics across the President's table very soon dispelled any such idea which might have occupied the minds of the members present.

We believe that the carefully written paper of Profs. Ayrton and Perry marks a distinct step in advance of what has been hitherto done. That it will form a valuable contribution to the subject of electro-dynamic transmission we do not doubt, since, to use the authors' own words, it was only on recognising that Thomson's solution of the most economical section to give to a conductor was quite inapplicable in a variety of cases, that they were led to attack the problem from a new standpoint.

We are inclined to think that the want of agreement between the authors of the paper and their critics is due to some misapprehension on the part of the latter. We are quite unable to discern in the reasoning of Ayrton and Perry any very serious ground of complaint, and we think it would be well if critics would endeavour to understand the meaning of a paper before they attempt hostile criticism, which means too frequently an exhibition of their own weakness.

Thomson's law for the most economical section to give to a conductor is doubtless known to most of our readers. The annual cost of transmitting an electric current from one place to another is made up of two quantities; the first being the interest and depreciation on the capital sunk in conductors, and the second being the annual money value of the horse-power wasted in heating the wires. Now, premising that the cost of a conductor per mile increases directly as its area or as the weight of copper in it, and that the waste per mile in transmitting the current is inversely as the area, it follows that for the sum of these two amounts to be a minimum they must be equal to each other. This is Thomson's law, which is capable of graphic demonstration in the following way: along O X let abscissæ represent values of d^2, d being the diameter of the cable. As on the above supposition the annual interest and depreciation cost is of the form $p\,d^2$, let us draw a line from O at an inclination such that ordinates represent to any convenient scale this cost for different values of d^2. The horse-power wasted in the conductor for a given current is inversely proportional to d^2, the annual cost of the power thus wasted depending on the price of coal in the district or on the cost of producing a horse-power at the place where the current is generated. We can determine this cost for any particular current, and a second curve must be plotted in which it is represented by ordinates for different values of d^2. We have now a straight line ascending from O towards the right to represent interest, and an hyperbola descending from the left to represent the cost of waste. The lines will cross at a point where d^2 is such that the two costs are equal to each other, and if a third curve be drawn in which ordinates represent the sum of the two costs, it will be found that the value of d^2, for which the sum is a minimum, corresponds with that at which the two costs are equal to each other.

But Thomson's law is true only on the assumption above made of the cost of conductors being proportional to d^2. Although Ayrton and Perry, in common with other writers on the subject, make the same assumption it is easy to see that this but very inadequately represents the true cost of supplying and putting down the mains. As a matter of fact, the curve which correctly represents the interest for different values of d^2 is more or less complicated, and alters its form for every district. Approximately it might be taken as a straight line where the ordinates have the value

$$m + p\,d^2,$$

m being a constant, which represents the interest on the capital paid for rights of way, spent on earthenware troughing for cables, breaking up streets, making the same good again, &c.

We have said that Thomson's law does not apply for a case like the above, and this can easily be shown from the curve we have just drawn. Allowing p to have the same value as before, let us, without altering its inclination, move the interest line upwards by an amount equal to m. To obtain the curve representing the sum of the two costs under this new condition the ordinates of the curve which formerly represented this must be lengthened by an amount equal to m. The total cost will now be shown to be a minimum when d^2 has the same value as before, but *for this minimum value the interest on the cost of conductors will no more equal the cost of the energy wasted in conveying the current, the former being greater than the latter and the disproportion depending on the value of m.* This is the case which is constantly recurring in electric lighting, and here Thomson's law, as ordinarily stated, gives us no guide. What we have to do is to determine for the particular district we are dealing with the interest cost for different values of d^2 and to draw, combined with

* "Economy in Electrical Conductors." A paper read before the Society of Telegraph Engineers and Electricians, by Profs. W. E. Ayrton, F.R.S., and John Perry, F.R.S., on March 11th, 1886 (see ELECTRICAL REVIEW for last week).

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the interest curve so obtained, the waste curves for the different currents we mean to employ. By plotting a series of curves to represent the sums of the two we can then determine the most economical section of conductor for any current, and, conversely, the most economical current for any section.

But we pass from considerations respecting Thomson's law to consider the problem solved by Ayrton and Perry. The law above referred to does not concern itself with the length of the conductor, nor with the power actually transmitted through it, but confines itself simply to the statement of a well known mathematical truth. When, therefore, the problem arises in which a definite amount of power has to be delivered at a certain distance from a generator, the difference of potential at the terminals of which is fixed, the law given by Thomson does not help us to a solution. This is the problem which has been solved mathematically by Ayrton and Perry, and, in this case, it is conditioned by both the difference of potential, V, at the terminals of the dynamo and the power in watts delivered at the end of the line being given. C, the current, and r, the resistance of the line, are two variables, and the problem is to co-relate C and r to each other so that under the conditions fixed by V and P the total cost of the transmission will be a minimum. In Thomson's solution the current was given and r was the sole variable; here it will be seen the problem is altogether different, and the law of economy which there applied is not the law which must be followed to obtain the best result under another set of conditions. The resistance of the line is inversely as d^2, but, as we have not before used r, it will simplify matters if we consider the line of such length that its resistance may be taken as the reciprocal of d^2. This corresponds to a length of about fifteen miles. That the power, P, may be transmitted with a difference of potential, V, at the dynamo, d^2, and C must always be related to each other so that

$$\frac{C}{d^2} = V - \frac{P}{C}$$

or

$$d^2 = \frac{C}{V - \frac{P}{C}}$$

In the case selected as an example by the authors of the paper, V is taken as 200 volts and P as 10,000 watts. Returning to our graphic method we can, by inserting values of C, find d^2 for each particular current, and from these plot a curve in which d^2 are represented as abscissæ and C as ordinates. The curve so plotted is a peculiar one. Approaching from the right with a slight upward inclination it bends over at some distance from O. Y. and returns to the right with a much steeper upward slope, thus revealing the fact that there are for each value of d^2 two values of C by which the above equation of transmission is realised.* For example, if C is made 300 ampères

$$d^2 = \frac{300}{200 - \frac{10,000}{300}} = 1·8$$

also if C is made 60 ampères

$$d^2 = \frac{60}{200 - \frac{10,000}{60}} = 1·8.$$

Again with C = 200 ampères

$$d^2 = \frac{200}{200 - \frac{10,000}{200}} = 1·\dot{3}$$

or C = 66·66 ampères

$$d^2 = \frac{66·66}{200 - \frac{10,000}{66·66}} = 1·\dot{3}$$

With these currents and values of d^2 we have:

For 300 ampères—

Received 300 × 200 = 60,000 watts.

Wasted $\frac{300 \times 300}{1·8}$ = 50,000 „

Transmitted = 10,000 „

For 60 ampères—

Received 60 × 200 = 12,000 watts.

Wasted $\frac{60 \times 60}{1·8}$ = 2,000 „

Transmitted = 10,000 „

For 200 ampères—

Received 200 × 200 = 40,000 watts.

Wasted $\frac{200 \times 200}{1·\dot{3}}$ = 30,000 „

Transmitted = 10,000 „

For 66·6 ampères—

Received 66·66 × 200 = 13,332 watts.

Wasted $\frac{66·66 \times 66·66}{1·\dot{3}}$ = 3,332 „

Transmitted = 10,000 „

From these figures it will be observed that there are any number of relations between the current and line resistance by which P can be delivered at one end, but we are not in a position yet to say which is most economical. From the curve already drawn we must plot another curve in which is represented, by ordinates drawn to any convenient scale, the annual cost of the power wasted for different values of d^2. We must also draw a curve to represent the interest for different values of d^2, when finally, by a curve showing the sum of the two, we can tell at a glance the particular value of d^2 which renders the total annual cost a minimum.

The curve we have obtained will represent the cost for one particular length of line wire only, and the question arises, how must a curve such as we have described be modified to obtain the cost for a different length of conductor? Let it be remembered that the relation between the current and resistance depends on V and P. It is independent of the length of the line through which the power is transmitted, and in the event of our making the line n times as long, d^2 must be made for each current n times greater that the relation between current and resistance may still hold good. Now, if the line is n times as long, for a value of d^2 n times greater, the resistance, the current, and the heat waste will be as before if the same power is to be transmitted, and we must therefore lengthen the abscissæ of the curve representing this n times, that the waste may be represented under the new condition for the different values of d^2. As regards the interest on the cost of conductors, it is evident that the ordinates of the interest curve must be increased n times, since the line is n times as long. By plotting a curve representing the sum of the ordinates of these two curves as modified, we obtain one which shows how the total annual cost depends on d^2. The facts revealed by the paper of Profs. Ayrton and Perry are completely borne out by the results obtained from the graphic methods we have described, and, to quote the authors, *if a given amount of electric power has to be furnished at the end of a line, with a given difference of potential at the dynamo, maximum economy is obtained, not by keeping the current density constant, but by making it diminish as the length of the line becomes greater. In all problems connected with*

* Excepting in one particular case which corresponds to the point on the extreme left of the curve where it bends over to return. In this case $d^2 = 1$ and C is 100 amps., half the total power put in being wasted in the conductor.

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the transmission of power where the maximum potential is given, a current smaller than given by Thomson's formula must be used to obtain maximum economy. This is clearly shown in Table I., where the figures have been calculated for a transmission of 20,000 watts with a potential of 200 volts.

We have been at some pains to place before our readers a graphic method of solving some of the problems mathematically dealt with in the paper under review, and for several reasons. As we have before stated, the cost of supplying and placing conductors underground, or even for erecting them overhead, does not depend simply on the weight of copper, and probably alters its amount relatively to the weight for every different locality. But the interest and depreciation on any line can be most conveniently plotted in a curve for different values of d^2. Again, under certain relations of d^2 to the interest cost, the curve for the total annual cost shows that the minimum is practically constant for a considerable variation of d^2, and when this is the case it will be a question depending on circumstances whether the waste in heating or interest is to be greatest. From the curves we can see at a glance how the total sum is made up, and if the installation is to be temporary, obviously it might often pay better to keep the specialised capital account low at the expense of using more coal per annum.

Profs. Ayrton and Perry in the concluding part of their paper offer further solutions respecting the most economic section to give to steel rails for telpher lines and to electric railway conductors. The solutions given for these special applications of electro-dynamic transmission are extremely instructive, but we believe that the more convenient way of solving such problems will be by graphic methods, where the actual interest cost of conductors must be plotted for each district. Be this as it may, the paper in question clearly reveals the way in which must be attacked in the future problems of the kind they have dealt with. Their contribution to the subject is one of value, and we are certain that it will meet with the appreciation it deserves from all electrical engineers.

CORRECTION OF AN ERROR IN ELECTRO-DYNAMICS.

IT is not unfrequently supposed, says Prof. W. L. Hooper in the New York *Electrician and Electrical Engineer*, that there is an expenditure of energy in the coils of an electro-magnet sustaining a load or in a coil of wire containing an iron core other than that due to the resistance *per se* of the wire.

The above is plainly stated in at least one somewhat prominent book on electricity with which I am familiar, and given as an illustration of the conservation of energy. Some months ago I undertook, with the assistance of one of my students, the investigation of this phenomena.

A tangent galvanometer with a coil having a diameter of about two-thirds of a meter consisting of five turns of stout wire was improvised. A piece of magnetised watch spring, 1 cm. in length, attached to the back of a small mirror hung by a silk fibre in a tight box constituted the needle. Deflections were read with a lamp and scale 1 m. distant. The battery, galvanometer and electro-magnet formed a simple circuit.

Owing to the facts that the needle was sometime in coming to rest and that the battery was not absolutely constant, changes in the current strength less than a considerable fraction of 1 per cent. could not certainly have been detected.

We accordingly tried another plan and made the electro-magnet one of the four resistances of what was practically a Wheatstone bridge arrangement. We were here troubled greatly by the unequal heating of the various conductors by the strong current used; nevertheless, if the apparent change in resistance of the electro-magnet when lifting a load had exceeded a few hundredths of 1 per cent. we should have detected it.

The same was true of a coil of wire with an iron core; no change due to the iron core was suspected.

It was here resolved to renew the experiments on the completion of a divided meter bridge then projected. The subject was accordingly again taken up a few weeks ago.

The slide wire of the bridge is a meter in length, the prolongations used in the side gaps were a little less and a little more respectively than 41·5 m. of the slide wire; hence the equivalent slide wire was about 84 m. in length. The electro-magnet was placed in one of the central gaps, in the other a nearly equal resistance carefully selected, so that the heat developed by the current should affect both alike.

The battery used consisted of six large bichromate dip cells having an electromotive force of 11·8 volts and an internal resistance of ·3 ohms. After some preliminary experimenting the following order was adhered to. After closing the battery circuit the armature with a load of about 65 lbs. was placed upon the electro-magnet; the man at the Thomson reflector in an adjoining room was then directed to close the galvanometer circuit, if necessary the bridge was adjusted till the spot of light stood steadily at zero.

The galvanometer circuit was then broken and immediately afterwards the battery circuit was opened, when the armature fell off; the circuits were then quickly closed in the inverse order and the deflections observed. After several precautions, unnecessary here to relate, had been adopted, the above could be done without any perceptible motion of the spot of light.

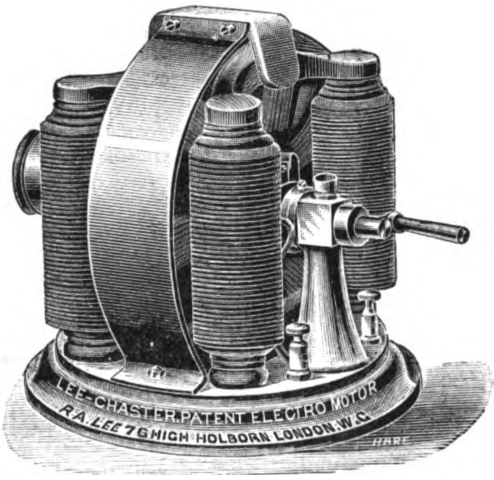
It will be remembered that the equivalent length of the slide wire was 84,000 mm.; now a motion of 1 mm. of the pointer was found to give a deflection of a little over three divisions on the scale of the galvanometer.

Hence it is not too much to say that if anything much exceeding the one-millionth of the energy of the current had been absorbed in doing work upon the armature of the electro-magnet, it would have been detected.

Of course, in the light of the modern theory of electro-dynamics the result could not have been otherwise; still, it seems to me important to correct mistakes by an appeal to experiment wherever possible.

THE LEE-CHASTER MOTOR AND BATTERY.

THE Lee-Chaster patent electro-motor, which we illustrate, is made by Mr. R. A. Lee, of 76, High Holborn,



W.C., and can be seen at his works applied to one of his ingenious shaping machines. Although occupying a space of 8 in. by 8 in. only, it is said to be capable of

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developing energy equal to nearly ¾ H.P., and can be started, stopped, or reversed by the simple movement of a switch. The device is more especially worthy of notice because it is driven by a battery which involves the minimum of trouble, which will run for about 20 hours without recharging, and can then be restarted with fresh solution in a very short time. The cells are charged with Lee's new double bichromate, which is soluble in its own weight of cold water, and which does not deposit crystals in the pores of the carbons or in the cells. Moulded corrugated carbons are used, and the zincs are so cut as to economise the metal as much as possible. The cells rest on a tray in a box, which tray can be raised by means of a treadle until the elements are fully immersed in the solution. Both zincs and carbons are suspended from a board, which forms a lid, so to speak, and the connections are made by means of brass plates, thus avoiding the use of wires. Two wing nuts hold this board to the mechanism of levers, and by removing them the whole battery of elements can be lifted out, leaving the cells exposed. The zincs and carbons are automatically removed from the solutions when the treadle is released, and the amount of immersion can be regulated to a nicety. We understand that preparations are being made for fitting a Lee-Chaster motor to a launch—work to which both motor and battery are well adapted.

CENTRAL ELECTRIC LIGHTING AT TOURS.

SOME months ago, writes M. Hospitalier in *La Nature*, we called the attention of our readers to the difficulties attending the distribution of electrical energy over a somewhat extensive radius from a common centre of distribution, and gave reasons justifying the employment of transformers. We will now briefly show their object. In order to diminish the loss of energy in an extensive canalisation without using large, cumbersome and expensive conductors, the current must be reduced as far as possible, and this involves the employment of high tensions and high potentials. But these high potentials are not directly practicable, and it is impossible to place them at the disposal of consumers, as they are very dangerous. These currents must therefore be modified or *transformed*, their electromotive force reduced and their volume increased, so as to suppress the dangers involved in their use, and render them directly practicable in the various applications of electricity of the present day; this is the object of *transformers*. We may even go so far as to assert that, at present, the *transport* of electrical energy at a high potential is incompatible with the *distribution* of the electrical energy so transported without the aid of transformers; it is upon the choice of transformers that opinions are divided. Some, like M. Marcel Deprez, seek to utilise the motive force produced at a distance, which force can there be employed in actuating electrical generators of less tension and greater current destined to effect a distribution over a smaller area.

It is very certain that even in the very improbable case of motive power being economically transported by the aid of continuous currents at a tension of 6,000 volts, the problem of the distribution and division of this force would still remain unsolved. We cannot, besides, entertain any great hopes of the utilisation of great natural forces at a distance, when we take into account the cost of installation, inevitable losses, the complications of the system, and, lastly, the instability of natural forces. In proof of this instability, we may mention that in the lighting of Lucerne by electricity by the Zipernowsky-Déri system, a steam engine of 250 H.P. is in reserve in order to provide against possible stoppages of the water power. Some experimentalists, like Messrs. Gaulard and Gibbs on the one hand, and Messrs. Zipernowsky, Déri and Blathy on the other, effect the transport by the aid of alternating currents of high tension, and the distribution by employing transformers. Others (and it is this system that is now being carried out at Vienna) effect the *transport* by the aid of a continuous current, the groups of accumulators being charged in series, and the distribution by means of these accumulators grouped in such a manner as to reduce the potential in the canalisation of distribution.

This last system is, in our opinion, by far the best, if we take into account the improvements yet to be made in accumulators. The continuous current allows of more varied applications than alternating ones; the accumulators, which in this particular case are only deferred transformers, enable the time of production to be separated from that of utilisation, and eventually allow of a maximum consumption far above the power of production of the works, and even provide against a complete stoppage of the works, thus offering the greatest security to consumers.

We will not, however, now discuss the continuous current distributions by means of accumulators and the future that awaits them, but confine ourselves to the present, and to M. E. L. Naze's interesting application of transformers to the lighting of the City of Tours. The central works are established on the Place du Palais de Justice, at one of the extremities of the Rue Royale, and the principal canalisation, which extends as far as the banks of the Loire, is about one kilometre in length. A distribution of this extent would have required a very expensive canalisation to maintain a constant and uniform potential throughout its length. It is, however, indispensable that this potential should remain constant, as we may see by the fact that an Edison lamp, working normally at 100 volts and producing 16 candles, gains or loses one candle per volt more or less. A difference of 4 volts, at different moments, would therefore cause a corresponding difference of 4 candles, or the fourth of the normal luminous power.

In order to avoid these variations of potential which are so prejudicial to the quality of the light, and also to the duration of the lamps, M. Naze employs a method which consists of establishing two distinct systems: a system of transport of 850 volts, feeding a certain number of transformers, the induced circuits of which supply a system of distribution, special to each one, and independent of one another, distributing at 50 volts only.

The motive power is produced by two compound or two-cylinder steam engines (Weyher and Richemond). In installations of this kind, engines with two cylinders are preferable to engines of long expansion in a single cylinder, because the motive couple being more constant, the variations of speed in each revolution become inappreciable. One of these engines has a nominal power of 100 H.P., the other of 150. They each drive a separate counter-shafting, which actuates a generating machine and its exciter. This arrangement of the engines enables them to work either separately or together as required.

The generating machines are on the Siemens system with alternating currents, type W_{100}. They each bear 30 bobbins, 28 only of which are used, the two others remaining in open circuit. The 28 bobbins used are coupled 7 in series and 4 parallel. At 550 revolutions per minute and an excitation of about 25 ampères, the machine produces 66 ampères and 850 volts at the terminals. With a total excitation of 40 ampères, the same coupling will give the same current, with 1,250 volts at the terminals, representing 82,500 watts or 112 electrical H.P. At 850 volts, the machine produces at present, when in full action, only 56,000 watts or 75 available electrical H.P.

Each machine supplies one side of the street. The transformers are arranged at certain points on the principal branch, and connected in parallel, as in the Zipernowsky system. One of these transformers is shown towards the right of the fig.: this is the one employed at the works in the measuring and regulating

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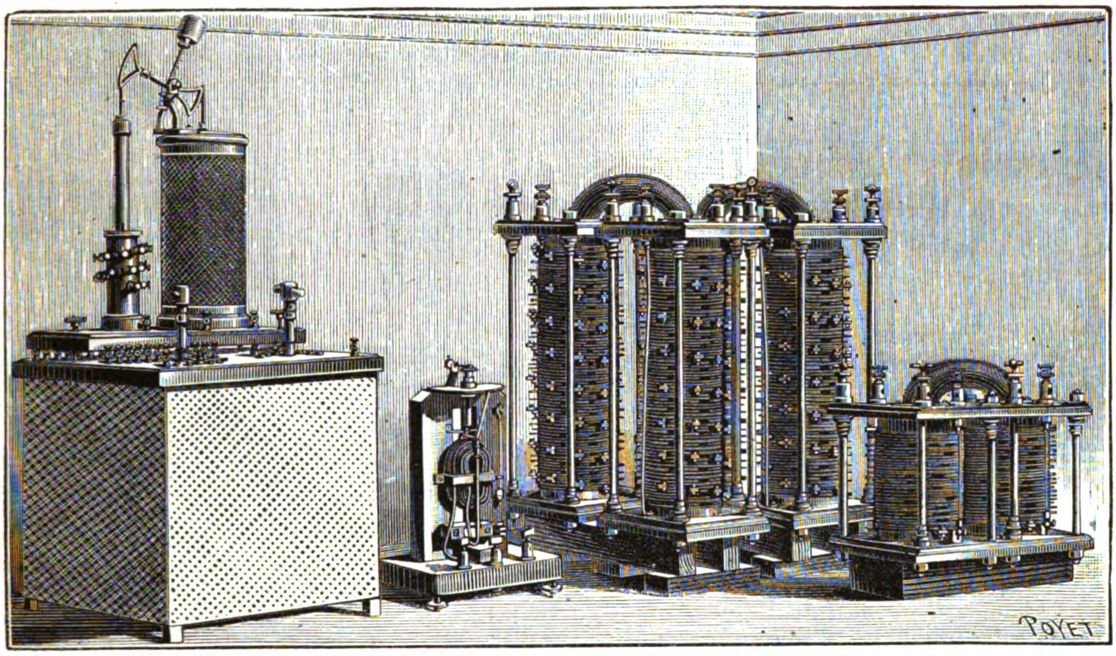
room, where it serves both to light the works and to show the good working of the system. It consists of four columns, the cores of which are coupled two by two, so as to constitute a closed magnetic circuit.

The inductive and induced circuits are constituted of copper discs soldered together and separated by sheets of asbestos. The four inductive circuits of four columns, forming a transformation group, are connected in series; the four induced circuits are joined up in parallel. The coupling of the discs in each column, and of the columns together, is such that a difference of potential of about 825 volts at the terminals of the primary circuit of a transformer keeps up a difference of potential of 50 volts only at the terminals of the secondary circuit, whatever may be the number of lamps lighted at each moment from zero up to a maximum of 250 ampères, representing the power of a four-column transformer. Under these conditions, each apparatus not distributing for more than 100 to 150 metres all round it, the loss of pressure in the branch is very slight, and the distribution is ensured by the aid of 48 volt lamps. The 16-candle lamps take about 1 ampère, the lamps of 10 candles 0·6 ampères, which amounts as near as possible to 3 watts per candle for either type.

formed by hand. When the potential in the transport canalisation reaches 1,250 volts, the regulation is effected automatically by the aid of an apparatus shown at the left of the fig. This regulator consists of a balance beam, from the extremities of which are suspended two iron cylinders; one of these cylinders is placed in the middle of a solenoid of fine wire; the other dips into a cavity containing mercury. The more or less powerful attraction of the solenoid inclines the beam more or less, and causes the other cylinder to plunge more or less deeply into the mercury. It also produces a change of level in this mercury, which is turned to account in introducing a variable resistance into the exciting circuit. The sensibility of the apparatus is regulated by displacing a counterpoise which is movable on a vertical rod fixed upon the beam. Thus the variations of potential at the terminals of the machine are limited, and it is kept practically constant.

Such are the principal features of the Tours installation. There are still many details left to describe as to the manner of reckoning the light used by consumers, the measurers of electricity in the study, the auxiliary transformers which re-transform the current of 50 volts and bring it to 100 volts to feed two arc lamps in tension, &c. (One of these transformers is shown at the right of the fig.). What we have said will suffice to show the advantages that have been drawn from M. Gaulard's transforming apparatus in their application to a distribution of the electric light.



Potential Regulator. Electro-Dynamometer. Four-column Transformer. Little Transformer.

FIG. 1.

Each column represents 4 H.P. of distribution, or 16 per group of four columns. When the distribution is at 1,250 volts, each group constituting a transformer will have six columns, and will be capable of distributing 24 H.P. under a potential of 50 volts and a current of 375 ampères.

In order to verify the potential at the terminals of each generating machine, for want of an industrial and practical voltmeter for the measurement of alternating currents, 17 incandescence lamps of 50 volts are employed, connected in series and placed as a shunt from the terminals of the machine.

On closing the circuit on these 17 lamps, they burn at their normal power if the potential is normal; they are somewhat feeble if the potential is too low and somewhat brighter if the potential is too high. They form a very reliable galvanoscope, the only defect being that more than one electrical H.P. is used for the measurement during the time that the current is closed upon the lamps.

The potential is kept constant at the terminals of the machine, whatever may be the expenditure in canalisation, by variable resistances being introduced into the circuit of the exciter. This regulation is now per-

A long trial will show the advantages and defects of this system; but, in any case, we are pleased to note the successful and intelligent initiative that has been given in this direction.

ELECTRICAL DISTRIBUTION.

PROF. GEORGE FORBES has written to the *Journal of the Society of Arts* respecting his recent paper on the above subject as follows:—On reading over the paper which I read to the Society of Arts on February 17th last, "On Some Points in Electrical Distribution,"* I find that, when speaking of secondary generators, there is an omission which may be apt to mislead. When treating of the arrangements of these generators *in*

* See ELECTRICAL REVIEW for February 26th, 1886.

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parallel, my remarks in the body of the paper have reference only to such generators as those which have been specially under my notice—where the difference of potential at the terminals either of the primary or secondary circuit is not so great as thousands of volts. I feel that I ought to have taken some notice of those generators in which the difference of potentials of the primary may be several thousand volts. In this case, of course the fall of potential in the main conductors is of far less moment. There a distance of a mile causes as little trouble as does 100 yards in a direct supply. The ratio of the maximum values of the difference of potentials at the terminals of the primary and secondary coils may be expressed by the following relation :—

$$\frac{V^2}{V'^2} = \frac{\rho^2 + 2\rho\, r' + r'^2}{\rho'^2 - 2\rho'\, r' + r'^2} + \frac{\rho^2\, r'^2}{(\rho'^2 - 2\rho'\, r' + r'^2)\, C^2}$$

Adopting the same notation as in the appendix to my lecture.

Now, r' is always very large compared with ρ', and ρ is large compared with r' in the present case. Hence, this reduces to $\frac{V^2}{V'^2} = \frac{\rho^2}{r'^2} + \frac{\rho^2}{C^2}$ approximately.

If C^2 be small compared with r'^2, then we might have $\frac{V^2}{V'^2} = \frac{\rho^2}{C^2}$ a constant. Hence it appears that, with a generator the resistance of whose secondary circuit is large, and the resistance of the primary coil large even when compared with that, we may attain a constant E.M.F. in the lamp circuit by maintaining constant pressure at the terminals of the primary, and (in the case where the E.M.F. of the dynamo is very great) this may be attained by keeping the E.M.F. at the terminals of the dynamo constant.

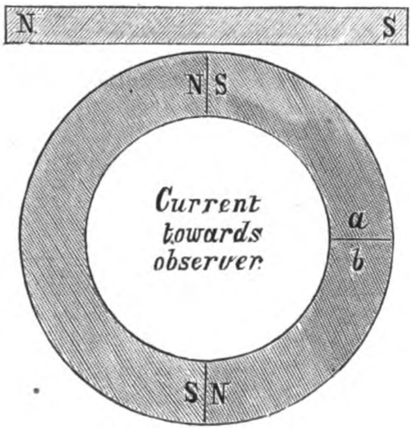

FIG. 1.

I have seen no experiments to judge how far this approximation has been reached in actual practice, but I have been promised to inspect such an arrangement shortly.

P.S.—Please notice the following erratum in the appendix to my paper. In the expression for V'^2—*for* $(r' + \rho')^2$ *read* $(r' - \rho')^2$.

"SELF-INDUCTION :" OR, THE EFFECTS DUE TO THE ELECTRO-MAGNETIC CAPACITY OF CONDUCTORS.

By DESMOND G. FITZGERALD.

IT would de difficult to overrate the importance—from a theoretical no less than from a practical point of view—of the questions raised by Prof. Hughes's admirable paper on "The Self-induction of an Electric Current in relation to the nature and form of its Conductor." Nor has the fact that these questions have been generally neglected—that the researches of Prof. Hughes are of almost startling originality—been sufficiently recognised. Due acknowledgement was made in the paper of the valuable labours of M. Gaugain in relation to the *variable periods* preceding and following the normal passage of a current; but, so far as I am aware, the French physicist has considered only the electro-static conditions prevailing during these periods, and did not take into account the effect of retardation due to what is termed "self-induction" or "the induction of a current on itself."

Now I may at once state, with every deference to Prof. Hughes, and also to Prof. Faraday—an investigator of the same order of mind, with whom the expressions just made use of originated—that one of the main objects I have in view in these observations is to quarrel with the terms in question. I maintain that they originated in a complete misconception of the nature of the phenomena which are also said to be due to "electro-magnetic inertia ;" and that, in the present condition of our knowledge, they should be considered as obsolete. I would further deprecate the use of the term "inductive capacity" of conductors in the same sense as "electro-magnetic inertia" on the grounds that it is likely to lead to confusion ; this term being already employed not only to correctly designate a property of dielectrics, but also to signify what should properly be expressed as the electrostatic or "charging" capacity of conductors under given conditions. According to my view, the phenomena ascribed to "the induction of a current on itself" are entirely due to the *electro-magnetic capacity* (or *resistance*, if we prefer

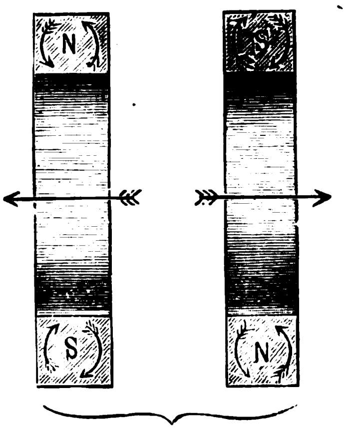

FIG. 2.

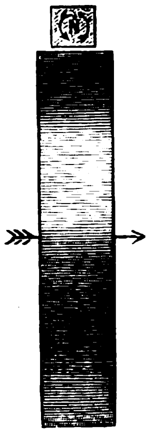

FIG. 3.

to take the reciprocal of capacity) of a circuit, or of a conductor, under given conditions. Moreover, in the variable period preceding the passage of the normal current, the effects supposed to be due to the induction on itself of the current in reality *precede* its passage, being consequent upon the establishment of conditions which are essential to conduction. At least this conclusion is consequent upon the admission that the maximum of magnetisation, under the given conditions, must exist in the conductor before the normal current can pass ; for, under the same law, *some degree* of magnetisation would be a condition necessary to the passage of *any* current.

In the *Electric Telegraph Review* for August 27th, 1870, I published the results of an investigation I had made of "the Magnetic polarity of conductors conveying an Electric Current." The following diagrams are taken from my paper under that heading ; and it will be seen that they represent transverse slices of a conductor conveying a current—the central portion of the sections being removed in order to exhibit the analogy between such transverse sections and a closed magnetic circuit formed of two "horse-shoe" magnets with their opposite poles in contact. I will assume for the present that it is generally known and admitted that the magnetic polarity of all conductors conveying a current is as here represented, and that if, for instance, the hollow cylinder shown in Fig. 1 were cut through the line between a and b, a north pole would appear at a and a south pole at b. And I need not

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here point out that, in the case even of a closed magnetic circuit, there exists a magnetic field external to the magnets; nor that the polarity shown, taken in conjunction with the fundamental law that "currents in the same direction attract, and currents in opposite directions repel, each other," affords a simple and unerring explanation of all the phenomena of attraction and repulsion between currents and magnets.

But one fact which may here be usefully referred to is that—although the electro-magnetic effect is greatly increased by giving to the conductor the form of a helix or coil, and is still further augmented by inserting a magnetic substance within the latter—a rectilinear conductor conveying a current is an elementary electro-magnet, similar in polarity to the coil with, or without, its core, and consequently tending to induce in the conductor an *inverse* current, *i.e.*, one in the direction opposite to that of the current which is said to generate the magnet. Now an electro-magnet cannot be generated without an expenditure of energy; it has in fact stored up in it the sometimes strikingly-considerable quantity of energy which re-appears in the induced *direct* current, or "extra current," during the variable period *following* the normal passage of the current. The question arises: Whence is this energy derived? An answer which, *primâ facie*, may appear equally simple and satisfactory, can be given to this question. The energy is derived from the battery, or other source of electrical supply, in the circuit. Whenever, as in this case, an opposing electromotive force is overcome, some portion of the work done by the current necessarily becomes stored as potential energy. For instance, let a given (normal) current, C, be diminished to $\frac{C}{2}$; firstly, by the insertion of a resistance (R becoming 2 R), and, secondly, by means of an opposing E.M.F., $e = \frac{E}{2}$. In case 1, the work, C E, done by the normal current in a given time becomes $\frac{C}{2}$ E, and the energy expended in heating the conductor is $\left(\frac{C}{2}\right)^2 2\,R = \frac{C^2}{2}\,R$. But $\frac{C^2}{2}\,R = \frac{C}{2}\,E$ (since $E = C\,R$); therefore, the whole of the work done by the current is expended in heating the conductor. In case 2, the work done by the current becomes $\frac{E - e}{R} E = \frac{C}{2}$ E, as before; but the energy expended in heating the conductor is now $\left(\frac{C}{2}\right)^2 R = \frac{C^2}{4}$ R, or half the former value; therefore, only half of the work done by the current is expended in heating the conductor. The remaining half, if it does not appear as mechanical work, usually becomes stored as some form of potential energy. Although, for the sake of simplicity, I have, in this example, taken only one value for e (which may represent the E.M.F. of the inverse current), it will be seen that, if this value vary from $e = E$ to $e = 0$, the energy expended in doing electro-magnetic work in the conductor will be the sum of the differences, during the variable period, of the successive values for total work and work expended as heat.

"Well! and what more," I may be asked, "can you require in explanation of the origin of the energy expended in doing electro-magnetic work upon the conductor? Can you deny the probability of the answer to the above questions which you have imperfectly sketched out, and would you resort to some far-fetched hypothesis of heat disappearing in the circuit in order to explain what is already so clear?" Bear with me a moment, please! I am no mathematician, and I have a weakness for endeavouring to represent to my "mind's eye," physically, what really does take place in a phenomenon so interesting as that of the *birth of magnetism*. I have some reason for thinking that what constitutes magnetism constitutes also the *modus agendi* of electrical conduction. Now, according to the above explanation, the current from the battery, overcoming the back E.M.F. in the conductor, during the variable period preceding the passage of the normal current, expends a portion of its energy in doing electro-magnetic work, *i.e.*, in generating magnetism. But can a current pass in a conductor prior to its becoming magnetic? If so, a conductor conveying a current is not necessarily magnetic. In the contrary case, the magnetic condition, at least initially, cannot be produced by the passage of the current. You see that, from my point of view, the explanation is defective or insufficient.

Let us drop this point and see if we can find, in other directions, not a theory, nor even perhaps a complete hypothesis, but suggestions for an hypothesis of conduction, involving the production of electro-magnetic work, and the appearance of magnetism, prior to, or simultaneously with the initial effect of conduction.

In the halved section of a hollow cylindrical conductor, shown in fig. 2, the circular currents indicated may be taken as those of Ampère's theory; but with a very important difference. During the last sixteen years I have repeatedly pointed out that Ampère's theory of magnetism is defective and illogical in one particular. He ascribes all magnetic effects to circular currents of electricity; whence it follows that such currents must exist in a rectilinear conductor conveying a current. So far we can go with him; but no farther. We may admit that the convolutions of a helix are the seat of two kinds of circular currents; but we cannot admit that *both* these, if *straightened out*, would still exhibit magnetic effect due to the attractions and repulsions between circular currents. We arrive immediately in fact at a *reductio ad absurdum*—an infinite number of circular currents within each circular current in a rectilinear conductor. It will be seen that, whereas Ampère's circular currents, if straightened out, would resemble other circular currents in exhibiting magnetic effect, we require, before we can accept the theory as physically true, to know of *a circular current exhibiting magnetic effect, which current, when "straightened out," will no longer exhibit magnetic effect.*

So long ago as July 3rd, 1868, I published in the *Engineer* a communication "On the production of a continuous electromotive force by the motion of a conductor in proximity to a static electrical charge," illustrated by the following diagram:—

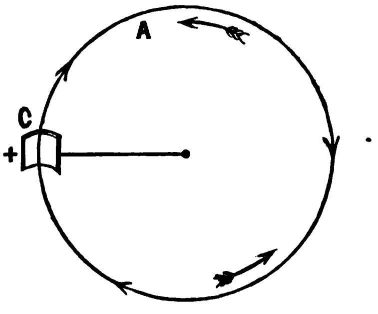

FIG. 4.

In relation to this, I then stated:—"If C be made to revolve round the centre of the circle, in the direction of the arrow-heads upon the circumference, the current, if the cylinder be positively charged, will be in the same direction as the motion of C, and the ring, A, will become a magnet having its south pole facing the observer."

Following the clue I had then obtained, and working with the very imperfect means of investigation then at my command, I was able to mention, in the above-mentioned issue of the *Electric Telegraph Review* (August 27th, 1870), that "it has been proved experimentally that the revolution of a charge, or the rotation of a conducting body in the vicinity of a charge, produces the magnetic effect of a circular current." I was afterwards led to admit that the *sign* of the charge has no effect upon the magnetic polarity consequent upon rotation in a given direction.

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This being understood, we may now regard the circular currents indicated in fig. 2 as the resultant of the rotation of molecules, one component of which, or one portion of the surface of which, is electrically charged.

At the present period, when the fact that "heat is a mode of motion" may be said to be universally recognised, and when the absence of molecular motion is clearly seen to imply the "absolute zero of temperature," few will have any difficulty in realising as a physical truth that "all matter is composed of atoms, or of molecules, not in actual contact, but surrounded by interatomic or intermolecular space." "Space," says Faraday, "must be considered as the only continuous portion of a body so constituted. Space will permeate all masses of matter in every direction like a net, except that in place of meshes it will form cells, isolating each atom (or molecule) from its neighbours, itself only being continuous." * But, argues Faraday, if space be an insulator there can be no transmission of electricity from atom to atom; whereas, if it be a conductor, it cannot exist in insulating bodies. Since the period when Faraday made this incautious statement, it has been shown, and I think conclusively, that vacuous space does not conduct electricity. And, I suppose, it will be readily granted that "if space be an insulator, but if a conducting atom charged with electricity can move through space into contact with another conducting atom, then there can be a transmission of electricity from atom to atom."

But why should one component only, or one portion only, of a molecule, forming portion of a conducting mass, receive an electrical charge? In the case of electrolytes, the question is readily answered; for it is a well-established law that "Those bodies only are electrolytes which are composed of a conductor and a non-conductor."

But how is this question to be answered in the case of simple conductors? I am forced to admit that I am not in a position to answer it conclusively in this case. I can only suggest that simple conductors and all the elementary bodies are analogous in their constitution to electrolytes; the molecules being formed of an electro-positive constituent capable of becoming electrically charged, and an electro-negative constituent which, under certain conditions of union with other molecules, is not susceptible of becoming so charged. But, in support of this suggestion, I may refer to the very interesting researches of Brodie (*Phil. Trans.*, 1850, 759, and 1862, 837), and also quote the following statement of an investigator—the late Prof. W. Allen Miller—whose premature decease was an irreparable loss to science and to those who had the privilege of knowing him.

"It is highly probable," says Dr. Miller, "that the isolated bodies usually viewed as elements should be regarded as compounds, the molecules of which consist of particles of the same element in opposite polar or electrical conditions. Hydrogen gas, for instance, is to be regarded as *hydride of hydrogen*, or a compound of hydrogen with hydrogen; chlorine gas as *chloride of chlorine*, and so on." Copper would thus be *cupride of copper*; iron, *ferride of iron*, &c.

I may briefly point out that the charged component of a molecule forming part of a conductive circuit, and also, necessarily, of an inductive circuit, would tend to move *outwards*, radially, rather than in the direction in which it would carry the charge towards the axis of conduction. Further, it may be assumed that the molecules of a conducting body in its normal condition, which molecules would have only their normal electrical charge, move or rotate in every possible direction; whereas these molecules, when the conducting body is conveying a current of electricity, *after the expiration of the variable period preceding the passage of the normal current*, rotate only in radial planes parallel to the axis of conduction.

With these explanations, I may now give a diagram representing a section through the axis of conduction of a "wire" of electrolyte, viz., sulphate of copper solution, and which more or less crudely expresses my notion of the *modus operandi* of conduction, both in electrolytes and in simple conductors, during the stable period of the passage of the current.

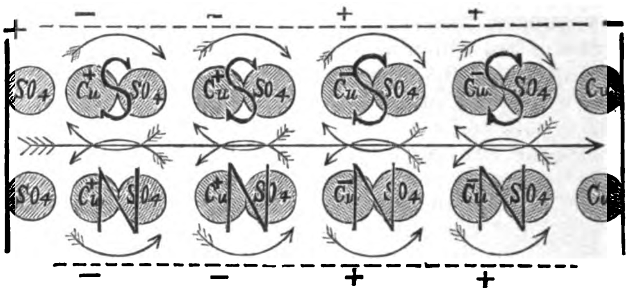

FIG. 5.

At the commencement of the variable period preceding the normal passage of the current, the molecules, I assume, are moving (rotating) in every possible direction. The observed first effect of the electromotive force of the source, brought to bear on the conductor, occurs in the inductive circuit; in the case of a coiled cable, for instance, the "current of charge" passes *instantly*, deflecting a galvanometer, placed between the source and the cable, in the same direction as that in which it is subsequently deflected, after the return of the needle to zero, by the normal current.* I shall not attempt the explanation of this phenomenon of the instantaneous passage of the current of charge—which is one of the interesting questions suggested by Prof. Hughes's paper—further than to observe that this current of charge, tending laterally, may possibly be conveyed by the moving molecules before the conditions for the longitudinal passage of the normal current are established. The next effect of the E.M.F. is, probably, to "polarise" the molecules, or to cause them to move in planes parallel to the axis of conduction; and the next is to arrest, and then to reverse, the motion of the molecules rotating in the direction opposite to that indicated in the diagram, and thus tending to transmit electricity in the direction opposite to that of the normal current. It is to be observed that the temporary arrestation of the motion of *molecules* would be attended by a temporary diminution of temperature.

I have great difficulty in representing to my mind the cause or causes of what has been with some reason characterised as the "terrific energy" of the "extra current," in the same direction as the normal current, which occurs during the variable period subsequent to the passage of the latter. In this second variable period it may, however, be assumed that the *virtual withdrawal of the magnets in the circuit*, *i.e.*, the change of motion due to the tendency of the molecules to move in every direction, is much more sudden than the corresponding *insertion of magnets in the circuit*, *i.e.*, the change of motion due to the action of an E.M.F. upon the conductor during the first variable period. It may be suggested that in the second period, when the external E.M.F. is withdrawn, the discharge of molecules may be effected by rotation in various planes; and this suggestion is susceptible of being confirmed or disproved by experimental observation, since, in the case supposed, the magnetic effect of the extra current—its action upon a galvanometer needle—would be less than that which would correspond with the quantity of electricity passing.

There is so much more for me to learn than to teach in relation to the questions I have touched upon, that my main object will be fulfilled if these questions receive from others the amount of consideration that may confirm or disprove the views—which are no more than possible glimpses of the truth—which I have ventured to put forward.

* Faraday as a discoverer. By John Tyndall, F.R.S.

* In the diagram the external + and − signs represent the charge induced in external conductors.

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AMERICAN TELEPHONE PATENTS.

WHAT purports to be a synopsis of the United States Government Bill against the Bell Telephone Company and Alexander Graham Bell, appeared in the *Washington Post* of the 18th inst. The matter is referred to in our Correspondence columns by Major Barney, who does not credit the authenticity of the document. The newspaper mentioned states that the Bill was to be filed at Columbus on the 15th inst., and that the Circuit Court in which it would be filed, and the local company against which the suit would be brought, were not yet decided upon. The preamble of the Bill sets forth that the suit is brought at the direction of Solicitor-General Goode, the Attorney-General being under disability to prosecute. The suit is brought under Section 8, Article 1, of the Constitution and the Acts of Congress passed thereunder, by which the United States is authorised and empowered under certain conditions to restrain all persons within its jurisdiction from exercising their natural rights to employ their industry, ingenuity and means in making, vending, operating, or using certain arts, machines, manufactures, or compositions of matter. The Bill explains that it is the duty of the applicant for any such patented monopoly to make known fully, fairly, and in good faith, to the proper officers of the United States, all matters within his knowledge relating to such invention or discovery, or in its connection with the history or state of the art to which such alleged invention or discovery belongs. When the applicant fails to do this it is within the power, as well as within the duty of the United States, to take such action or proceedings as may be convenient and necessary to cause the facts to be brought to a fair, impartial, and judicial investigation and determination. In performance of this duty the United States charges that certain Letters Patent issued to Alexander Graham Bell, dated March 7th, 1876, numbered 174,465, and January 30th, 1877, numbered 186,788, were illegally and improperly procured to be issued, and for this reason brings this Bill in equity as a means of causing justice to be done. It is claimed that Prof. Bell, although up to time of the issuing of his patent he had never been able to transmit articulate speech by the method or with the apparatus described in his application, purposely framed his application and claim in ambiguous and general terms, in order to cover both antecedent and future inventions, and to deceive and mislead the examiners of the Patent Office and the public. Prof. Bell is plainly charged with not only failing to meet the requirements of the law, but with misleading and deceiving the examining officials of the Patent Office. By carefully refraining from any reference to the transmission of articulate speech by electricity, he caused these officers not to make any inquiry as to the state of that art or the patent or the printed publications concerning it; wherefore the United States avers that the patent issued upon such delusive and ambiguous application was and is void, and of no effect. The case of Prof. Elisha Gray is entered upon at length, and it is charged that the wording of Prof. Gray's caveat became known to Bell through the examining officers of the Patent Office, and that by reason of collusion between the examiner Wilbur, Prof. Bell, and his attorneys, Gray was induced to abandon his caveat. Attention is also called to the fact that Bell claims to be the original and first discoverer or inventor of what is called the undulatory current of electricity, whereas that current was described by Faraday and other writers on electrical science, and that the combination of the magnet and the closed circuit, which Bell also claimed to be original with him, were used in the inducting telegraphs of Gauss, Weber, and Siemens. Under the head of "prior use, knowledge, and publication," the United States charges that Bell was anticipated in the discovery of the electrical speaking telephone by Philip Reis, Cromwell Fleetwood Varley, Antonio Muecci, Elisha Gray, Thomas A. Edison, Asabel K. Eaton, and many others, and it is claimed that this valuable discovery is either the property of some one of these prior discoverers, or, having been abandoned by the first and original discoverer or inventor to the public, is now free to be used by all the people of the United States. The Bill then takes up the patent of January 30th, 1877, and it is claimed that when Bell applied for it he well knew that every material part, portion, and device and apparatus set forth and described therein was not his invention. It is further claimed that this patent was obtained by fraud upon Amos E. Dolbear, professor of physics at Tuft's College in Massachusetts. Dolbear, it is alleged, discovered and invented the magneto-telephone now used as a receiver by the American Bell Telephone Company, but that, in order to obtain a patent for his invention, he communicated his design to a friend, Percival D. Richards, who, being a friend of Bell's, communicated Dolbear's invention to him, and the patent of January, 1877, was the result. It is stated that the Dowd case was a collusive one, brought to deceive the public and sustain the monopoly by an apparently legal decision. It is stated to the Court that only the Government, and not a private citizen, can bring suit to repeal the patents granted to Bell, and the Court is therefore prayed to decree that the two supposed patents described "be in all things recalled, repealed, and decreed absolutely null, and that the record thereof, and of each of them, as the same exists and remains in the Patent Office of the United States, or in any of the archives of the United States, be in all things expunged, erased, and obliterated, and that your orator and all the people of the United States be in all things restored and reinstated as near as may be to the actual condition and state existing prior to the inception and execution of the said scheme of the said Bell to unjustly obtain the issue and delivery to him of said wrongfully obtained letters patent." The Court is prayed also that if the patents are not to be wholly repealed the Court shall decide in what part they are void, and make a decree covering that portion of the patent which is wrong and illegal.

MILL LIGHTING BY ELECTRICITY.

AN extensive addition to the electric lighting system at the mills of Messrs. S. C. Lister & Co., Manningham, Bradford, is in course of completion. It is four years since electric lighting was first introduced at these mills, and since that time several prolonged experiments have been carried out, and small alterations made from time to time. The lamp which the firm has found to give the most satisfaction is the "Pilsen," manufactured by Paterson & Cooper, and it is now intended to fix 100 of that type, of 1,000 candle power each. To permit of the present extension being properly carried out, and in order to ensure the best possible arrangements for the proper maintenance of the light, it was determined that the dynamos and other apparatus should be placed together, instead of being fixed at different parts of the mills. Accordingly, a large shed, now known as the "dynamo-shed," has been set apart exclusively for the machinery and appliances connected with the light. At one end of the shed a double-cylinder "Robey" engine, capable of working up to 100 horse-power, is fixed upon a solid concrete foundation. The engine was specially built for the work it is now doing, and it is fitted with a Buss governor, double driving wheels, and other improvements calculated to ensure steadiness in running. The number of dynamos presently in use comprises four of Paterson & Cooper's Phœnix machines with 14 1,000-candle lamps on each, one Pilsen-Joel with 20 1,000-candle lamps, and one Gramme with one 3,000-candle lamp. Two more three-light Gramme machines are being got ready for use. The "Phœnix" dynamos have given great satisfaction so far. They have been run as long as 16 hours without any appreciable heating, and there is no sparking at the brushes. Each dynamo is fitted with a safety-fuse, and the wires leading from them to the switch box are very carefully laid under the floor in wooden groves. As far as possible, both in the dynamo shed and elsewhere, the negative and positive leads are kept well apart, and the risk of fire from short circuiting is reduced to a minimum. At the switch box the wires from each dynamo pass through the respective switches, and in every circuit an ammeter and regulating resistance of 1 to 5 ohms is placed. There is also a voltmeter which the attendant can switch on to any of the dynamos when necessary, and at the top of the box resistances are arranged in case it should become necessary to remove lamps from any of the circuits. Leaving the switch box, the wires run in wooden grooves under the floor and up the inside of the wall to the top of the dynamo shed, whence they radiate to the different parts of the mill on large insulators fixed to substantial wooden standards. Those departments of the mills in which the light has practically replaced gas illumination are where the manufacture and examination of velvets, plush, and imitation sealskin are carried on. In nearly all of the rooms devoted to these purposes it had formerly been impossible to work after the hour when it was necessary for the gas to be lit. Under the new system, however, the work may be carried on at any hour of the night or during the dullest days, it being quite possible to strike the nicest shades of colour or match the most delicate patterns by means of the electric light. The nature of Messrs. Lister's business very often requires night work to be performed, and they have therefore adopted electric lighting in the departments named more as a matter of necessity than from any motive of economy, although they anticipate that the new light could if necessary be worked at quite as moderate rate as gas.

To give some idea of the power of the light and the great revolution it must effect in the working of Messrs. Lister's business, what is known as the "Blue Shed," in which there are the greatest number of lamps, may be cited as an example. In this shed there are some 60 shearing machines, and for the purpose of enabling the work to be carried on at night, 14 arc lamps of 1,000 candle-power each have been erected. Under the system of gas illumination two and a half gas jets were required for each machine, or about 150 to carry on the work of the shed. Even then the process could not go on with any degree of accuracy or reliability, and in addition the great heat of the gas was almost unbearable.

The Pilsen lamps are used throughout the works, and in many cases, the more especially when they are used for the examination of goods, the light is naked, so that a greater concentration of light can be brought to bear on the delicate colours, and on flaws that might appear in the pieces, than would be obtainable with a globe. Globes are, however, used where a diffusion of light is necessary; and the same object is obtained by the use of large white shades. It may be mentioned that 12 lamps of 1,000 candle-power are presently used in connection with the erection of a new shed, so that work may be carried on at night; and the masons are said to prefer the light to the actual light of day. These outside lamps were erected and put in working order in less than two days, and we may hope that public opinion of outside lighting, which must have been severely shaken in the Bradford district by the failure which occurred in connection with the lighting of the building operations at the Saltaire Palace of Delight, will thus be re-established. The light at Manningham Mills, both under cover

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and in the open air, is absolutely steady, and gives great satisfaction to Messrs. Lister, who contemplate a still more extensive use of it. The installation has been carried out for Messrs. Paterson and Cooper by Mr. Thomas Preece, through their representative Mr. Wilson Woodhead, and under the personal supervision of Mr. Wm. Driver, one of the principals at the mills.

THE AMERICAN NATIONAL ELECTRIC LIGHT ASSOCIATION.

THE HISTORY AND PROGRESS OF ELECTRICITY AS APPLIED TO MOTORS.

By Mr. W. J. JOHNSTON.

AFTER alluding to the work of M. Marcel Deprez, Messrs. Siemens and Halske, Prof. Fleeming Jenkin, and others, with which our readers are already familiar, Mr. JOHNSTON continued:—Thus far the electro-motor has been discussed principally in its relation to the past. This, however, is a fitting occasion to cast a glance toward the future and to consider some points which are of special interest to this Association. I refer to a general distribution of power by electricity. In considering this problem, it may be well at the outset to set at rest some misconceptions which have unfortunately gained ground, due to the unguarded statements of enthusiasts. The question of economy is a matter of great importance here. The cost per horse-power per annum when using a stationary steam engine as the prime mover is a quantity variable with the conditions of the engine and the magnitude of the power. It is evident that a plant of 100 horse-power or more can be maintained more economically per horse-power than one of 25 H.P. or less. It would take me too long to demonstrate this by actual figures, and indeed the statement is so obvious that it hardly requires special demonstration. It is evident, therefore, that with increasing powers a point is reached at and beyond which the cost of power can be maintained in an independent establishment with equal economy to that of a central station itself, but that below that point the power can be supplied more economically by electricity from a central station. It would be impossible to lay down a universal rule as to this critical point in the power, for evidently it must vary according to locality and other conditions.

While the exact limits are variable, a slight consideration makes it evident that a general power distribution must be designed, so as to meet the requirements of a large number of comparatively small motors in circuit. I need not recapitulate many attempts that have been made to supply the demand for a small motor to perform intermittent services of widely differing character. Modern civilisation has created almost as great a demand for power as for such other adjuncts of convenience or necessity as light, water and heat. The advent, within the last few years, of numerous small gas, steam, water and petroleum engines, bears witness to this.

How many small workshops there are in which a reliable power from a central station would be a boon. In how many situations would such a small motor replace costly manual labour or animal power. A little consideration of this subject cannot fail to impress any practical man with its importance, and to give rise to the hope that it will soon receive the attention it deserves. When we consider further the fact that a double copper conductor, one square inch in section, is able to transmit 250 horse-power over a moderately long distance, without appreciable loss and without danger to life, and take this in connection with the present low price of copper, we must all admit the advisability of studying the problem of power distribution with the same energy as that of the electric light.

Several attempts have already been made to utilise lighting dynamos during the daytime for the purpose of running electro-motors in the circuits.

There seems to be no good reason why most electric light stations should lie idle and unproductive during 10 hours of the day when with their spare dynamo or two to guard against accident, they could easily be converted into a power station. Reference is here made particularly to arc light stations (as they are at present in the majority) in which the wires existing are strung overhead, so that a motor in a building can be attached without any delay or interruption of service.

In order to make such a service feasible, however, the electro-motors employed, whether they be in series, as on arc circuits, or in parallel, as on incandescent lamp circuits, must be designed so as to maintain uniformity of action under the most varying external conditions. Uniform speed under all conditions of load is probably one of the principal requisites of any motor, and hence not less so of the electro-motor, and different constructors have solved the problem of securing the desideratum, by mechanical or electrical means, into a description of which it is not necessary to enter.

But while good regulation is an essential element in a successful motor, that of high efficiency is of perhaps still greater importance. While the electro-motor has been the subject of extended study, it cannot be said that any definite and generally accepted rules have as yet been laid down regarding its construction, in the same sense, at least, as for the dynamo. That considerable remains to be done in this field is evidenced by the fact that up to the present the efficiency of motors has, as a rule, been comparatively low. There seems to be no good reason, however, why the electrical efficiency of a motor should not approach that of the dynamo, within limits, and the proper proportioning of parts and the study of their interdependence can alone bring about improvement over the present state of things. The efficiency, while comparatively low in large electro-motors, is still lower in the small ones, which is particularly unfortunate, from our point of view, as it has already been shown that the small motor will constitute the principal factor in an electric power distribution. It may be set down as an axiom that a small machine rarely equals in efficiency a large one of the same type, but the difference which exists in the case of the electro-motor is in many cases out of all proportion and irreconcilable with the simple conditions involved. As has been recently pointed out in the *Electrical World*, the small electro-motor requires a thorough overhauling, and already one of our most prominent electricians has succeeded, by a series of experiments, in obtaining efficiencies in a small motor which have rarely been attained by the largest. These experiments are not yet finished, and hence are not ready for public discussion, but they will soon form the subject of general attention, as they mark a decided advance.

While recommending the utilisation of electric light stations for power distribution during the day time, I would have it borne in mind that various conditions must be observed which necessarily enter into such a problem, and in which both the engineer and electrician could be profitably consulted.

The length already attained by this paper prevents me from giving more attention here to the history of electricity as applied to motors. I have already touched upon it incidentally. The sources of information on this branch of the subject are so numerous and so well known that I have taken it for granted that electric light men are generally acquainted with the past, and that it is the present and future that is of the most practical interest and value to them.

The future of electro-motors was never so bright as at present, and when our electricians shall devote themselves to this field of applied electricity with the same zeal as they have shown in other departments, we may expect as great an advance in the solution of the power problem as has been effected by the electric light in that of illumination. The field is " white unto harvest," and only requires intelligent working.

I wish to say here that in the preparation of this report I have received valuable assistance from Mr. Wetzler, of the editorial staff of the *Electrical World*, who has devoted much thought and attention to the transmission of power. In conclusion, I trust that this paper will have some effect in drawing the attention of electric light men to this important subject, and that we shall all live to see and enjoy the full realisation of the expectation of early enthusiasts regarding the electro-motor.

At the close of the paper,

Mr. MARTIN stated that Mr. Johnston had hoped to be present himself, but was unable from ill-health, having contracted rheumatism in a blizzard and snowstorm while on his way to Chicago to attend the first meeting of the association. In fact, Mr. Johnston's attendance at the first meeting had unfortunately been the means of precluding him from attendance at the third.

Mr. A. F. UPTON said that they must all have heard with interest and profit the very able paper just presented, and he added the subjoined remarks: At the electrical convention held last August in New York City, in a paper I had the honour to read at that time, in speaking of electric lighting stations, the following remark was made: " There is one thing occurs to me I think electric light companies should take into consideration, and that is, letting of power."

At the Edison Company's station, Lawrence, Mass., a large number of Sprague motors are used which run all day. They use from half a horse-power to five horse-power each. These Sprague motors are all employed at a good profit, and it has always seemed to me that every electric light company should use their power in the day time to run small machinery. You have it in your stations; why not use it?

Since then, information on this subject has been sought in every way and from all available sources. Electric power, in many places, has for some time been sold from central stations, just as steam power is sold, and with profit to both seller and buyer. In Boston this has been done by the Daft Electric Power Company, using the Daft system, and considerations of the results here attained will suffice to show the commercial value of electric transmissions. Dynamos are run by an Armington and Sims Company's engine, at a central station, supplying electric power to about thirty motors in various parts of the city. It is sold at $150 per horse-power per year, the price at present being about the same as that for steam for small powers. It is a curious circumstance that more power is sold than the engine can supply—a paradoxical state of affairs explained by the fact that almost no set of machinery is kept running steadily, and the company supplying power gains by the stoppages. At this station they have in use two Daft dynamos of 25 horse-power each that are run by being belted direct to a 50 horse-power Armington and Sims engine. The steam is generated in a steel tubular boiler set with the Jarvis furnace, and coal screenings are used for fuel. This power is transmitted all over the city, and is used for running all kinds of machinery, including sewing machines, ventilator fans, printing presses, elevators, and other work. The demand for power far exceeds the supply, as the company have let all the capacity of their engine, and have applications for 300 horse-power more. It is the intention of this company to start a large

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central station to be run exclusively to let power. The present plant has been in operation over eighteen months, and the only interruption has been three hours, when other parties cut their wires by mistake. In many cases these motors have supplanted small steam engines, gas engines, and hired power. Customers claim that the power is more regular than they have ever used before even when coming from the adjoining buildings. There is in Boston one engine running 29 elevators; if every elevator was used at the same time the engine would not have over one-half the required power.

From all the information gained, the actual loss in the process of conversion of power into electricity and transmitting power from the dynamo to the receiver amounts to about 40 to 50 per cent. The manufacturers of the dynamos claim only a loss of 30 to 40 per cent., but it is a safe calculation to allow a loss of one-half. This, as has been explained, is more than made up by the excess of power that can be actually sold and paid for. Electrical transmission has the unparalleled advantage of being superior to the obstacle presented by distance. Then again, it operates its miracles in perfect silence and repose. No force appears in the wire such as appears in shafting, in pipes with compressed air or water, in endless chains or belts; and, in case of powerful currents, insulation is easy. The conductor can be bent or shifted in any way while transmitting many horse-power, provided, of course, its continuity be not interrupted. It can be carried round the sharpest corners, through the most private rooms, into places where no other transmitter of power could possibly be taken. There is nothing to burst or to give way. In short, such a method of transmission is the acme of dynamical science. At the present time steam is the foundation of electrical power. Water power is unsteady and not reliable; gas motors are of limited power. With improved steam engines, belted direct to dynamos and the Jarvis process of utilising low cost waste fuels, the cost of making power has been reduced within the past few years fully one-half.

The most important use to which the principle of electric transmission of power is at present being put, is the running of street railways. It was only a little over five years ago that the first electric railway was built in Germany, and to-day there are many in that country where their practical success has been demonstrated. In France and England they are fast becoming popular, but it seems that those in America are yet almost of an experimental nature; in this branch of electrical science at least, America, is far from foremost.

The advantages of electricity over steam for railway purposes are many and great. In the first place, the bulky locomotive is done away with, as the electro-motor can be placed either under the car or on trucks by itself; in either case great weight and room being saved. The machinery for converting the coal into the power, or rather extracting the power from the coal is not portable, but stationary, and can be placed in the most convenient spot. For transmitting the power, in many cases, no difficulty has been experienced in using one middle rail as the conductor. Sometimes it has been found that the dirt sticking to the rails and the wheels formed a sort of crust so insulating as to prevent adequate communication. From all the information I can gain on this subject, it is, my opinion, that the most practical way will be to use wires on poles. I understand this system is used in the West by the Van Depoele Company. The poles can also be made available for stringing electric wires for both incandescent and arc lighting. The future of this system is filled with possibilities. It will eventually become the motive power of all the present horse railroads. In a few years elevated electrical railroads will be as plenty as steam railroads are now, and in time it will supersede the present system of running locomotives on all railroads—and why not? It is simply a question of cost of making power. It is acknowledged by every practical engineer that the present system of making steam in locomotive boilers is expensive as well as wasteful. The evaporation of pounds of water to each pound of coal consumed to make steam in locomotive boilers does not average over three and one-half pounds of water, using the best grades of bituminous coal, while with stationary boilers set to burn coal screenings for fuel, an evaporation of nine pounds of water to one pound of fuel is made, and the reduction in cost of fuel is from one-third to one-half. It is only a question of time when all the different electric lighting stations in this country will use their engines in the daytime to make power to be sold for manufacturing purposes, the same as they sell power in the form of electric lights now. They can also furnish power to run electrical railways, elevated or surface. The economy of this system over the cost of running horses, as used now, will be over 50 per cent.

As to speed, it is impossible to give the limit which can be reached on electric railways, because those so far constructed are on streets or in localities where very rapid transit is not possible or desirable. On the very first one built, a rate of seven miles per hour was customary. On the Berlin railway, opened in 1881, the greatest speed reached was at the rate of 18 miles per hour. More was possible, but the police authorities refused to permit more than 9 miles per hour. Up to August, 1882, there had been no breakdown on this road. On the Siemens railway, at the Paris Exhibition of September, 1881, a distance of over 1,600 feet was traversed in a minute, which is at the rate of nearly 20 miles per hour. There is every probability that electric locomotives can be run faster than any steam locomotive now in use. About 10 miles an hour is the average speed that a car can be run on an electrical street railway, but I think it is possible to run at the rate of 100 miles an hour. In the near future, on elevated railways, this will no doubt be accomplished. I believe the time will come when cars will be run by electricity between Boston and New York in about two hours' time, where it now requires six hours by steam railroads. We Yankees call ourselves practical people; we believe in the success of the use of electricity for elevated and surface street railways; believing this, we propose to put it into actual practical operation. Petitions are now before the present Legislature of the State of Massachusetts for charters for over a dozen street railways, part surface and part elevated, all to be run by some system of electric motors. In Massachusetts a horse railroad can be started under the general law, but as the law stands now an electrical railway requires a special charter. A petition has been presented asking for an amendment to the General Law and allowing electrical railways to be started the same as horse railroads are started now. We believe that the cost of power, as compared with the present cost of using horses, will show an economy of over 50 per cent. In the town of Winthrop, Mass., near Boston, sufficient money has been subscribed for erecting an elevated railway on the Enos system, to be run by electricity. The station will be constructed so as to include the use of dynamos for electric lights, and the elevated railway will be utilised for stringing wires to run them. If the charter is granted, work on this railway will be started at once. The plans are all made for an electrical station three stories high, the upper stories to be used as a manufactory and power supplied from the station below—a most profitable way of utilising the power of electric light stations in the day-time.

The electric station of the future will be erected to utilise power in hundreds of ways not now thought of. Central stations should be made large enough to combine all the present methods of using electricity, with full allowances for future discoveries, for I believe electricity is in its infancy. By this strange and novel agency power will be used to do its share toward the support and advancement of the human race. We may yet know, in our time, what electricity is, for to-day we only know it is a power that shows itself by its manifestations.

Electric light and power stations will be erected in the future as large as our present cotton mills; the engines will be used in the day-time to run lines of shafting to furnish power for manufacturing purposes, over the station; power motors will transmit electricity all over our cities to run small machinery. Both arc and incandescent lights will be used. Perhaps storage may yet be a success. Electricity will be used to drive machinery, to produce ventilation, for heating purposes; the exhaust steam will also be used for heating neighbouring buildings in cold weather.

There is no need to expatiate upon the advantages to be gained from an economical method of transmitting power; the costly and persistent attempts of inventors and capitalists to get better methods are enough to prove their desirability.

Many systems have been tried and found wanting. In electricity, thanks to living inventors, we have a force into which power can be transformed, as by the wave of the magician's wand, a force which flows to any distance with the rapidity of lightning and the stillness of a ray of sunlight, and then at bidding resumes its original shape quicker than thought can follow it.

An animated discussion ensued, it being evident from the remarks made that the members were becoming keenly alive to the importance of an early investigation of the power question.

As to Lawrence, Mass., Mr. Martin said he had had lately a letter from the Lawrence *American*, in which it was stated that that paper was effecting an economy of not less than 40 per cent. on power cost by the use of electro-motors, besides being free from the trouble and annoyance of a steam plant of its own.

Mr. De Camp thought that in order to furnish the power, stations must have new equipment, the spare or reserve plant being altogether inadequate for such purpose. He stated, however, that his company in Philadelphia were now running a number of sewing machines, averaging twelve to the horse-power.

An alternative was suggested by more than one member in the use of storage batteries, should it not be desired to enlarge the plant; and

Mr. Morrison expressed from the chair his firm conviction that the storage battery would within the next twelve months do all that might be required of it in this line.

LEGAL.

United Telephone Company v. Fleming.—This was a motion on behalf of the defendant before Mr. Justice Chitty, on Saturday, that the New Telephone Company might be made a party to an action for infringement. Mr. Bousfield, appearing for the defendant, stated that the terms of the summons were for the delivery by the defendant of all carbon telephones in his possession and for an injunction against any further manufacture, use, or sale of such telephones. Two years ago Mr. Fleming sold two Butler telephones, and these he was prepared to admit were infringements of the United Telephone Company's instruments; within the last few months he had begun to open up a trade in Valve telephones, supplied to him by the New Telephone Company.

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The United Company had for a long time past contended in its notices that the Valve telephone was an infringement of the Edison patent, upon which the present action was founded. The New Telephone Company had guaranteed the defendant immunity from an action for infringement, and desired to be allowed to defend the action. Since the United Company, however, had learnt that the New Telephone Company was coming in to defend any attack upon its instruments, it had declared that it did not intend to proceed with respect to the Valve instruments at the moment. The Butler transaction was an isolated one, and was admitted. The wording of the particulars in which the plaintiff company asked for an injunction was such that the defendant feared that, although no direct reference was made to the Valve telephone, when the injunction was granted, it would be held to include that instrument, and an impression would be created, to the detriment of those engaged in selling it, that it had been decided against by the Court. The New Telephone Company was represented by counsel, who expressed the willingness of the company to defend the action. Mr. Moulton, Q.C., for the United Telephone Company, said that company did not believe what the defendant said about the Butler transaction being an isolated one. It could be proved that within two weeks of the action telephones of the Butler type had been seen in defendant's shop. Mr. Bousfield stated that those were the receivers corresponding to the transmitters which were sold two years ago. Mr. Moulton said they were not proceeding against the defendant in this action in reference to any Valve telephones. After some discussion, he intimated his willingness to re-word the particulars of the summons, so that they should be confined entirely to the Butler instruments. To this course his lordship consented.

Blundell v. The Gulcher Electric Light and Power Company, Limited.—This case was heard in the Queen's Bench Division, before Lord Coleridge and a special Jury, on Wednesday. It was an action brought by the plaintiff, formerly the chairman of the company, to recover the sum of £164 18s. 2d., being fees due to him under the articles of association as a director. The defendants counter-claimed for the amount of certain calls on shares held by Mr. Blundell in the company (made after the bringing of the action), which was admitted, and the claim thus reduced to £37 ; and they denied that any balance was due to the plaintiff by reason of misconduct in the management of the affairs of the company. The misconduct alleged was some irregularity with reference to the allotment, and the plaintiff went into the witness-box and underwent a stringent cross-examination as to the matter, at the close of which, the jury intimated that even assuming that the defendants proved their case, as indicated by the line of the cross-examination, by means of affirmation evidence, they did not see that there had been anything approaching to such misconduct or irregularity as should disentitle Mr. Blundell to his fees. The case was then abandoned, and his Lordship gave judgment for the plaintiff for £37, with costs on the superior court scale. Mr. Self, Q.C., and Mr. Wood-Hill were counsel for the plaintiff, while Mr. French, Q.C., and Mr. Vaughan Williams appeared for the defendants.

Universal Electric Company, Limited.—The First Division of the Court of Session, Edinburgh, last Friday, on the petition of the liquidators of the Universal Electric Company, Limited, dissolved the company and exonerated the liquidators.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XIV.

HITHERTO we have merely taken a general survey of our subject, and we have endeavoured to ascertain the power required for the propulsion of tramcars, and the losses attending the transmission and the conversion of mechanical into electrical energy. Several methods of testing electro-motors by means of absorption-dynamometers were considered at some length in the earlier articles.

Constructive details concerning motors and the gearing to be employed for the transmission of motion from the motor shaft to that of the driven wheels will next occupy our attention. All modern dynamo machines can, with very little modification, be used as electro-motors, but few of the very best of these dynamos will be found suitable for the purposes of locomotion. In fact, the most efficient of modern dynamos are the least suitable for tramcar propulsion, both on account of their shape and the great weight; we are therefore justified in drawing a distinction between an efficient dynamo and an efficient motor. We are inclined to think that this distinction will grow wider with experience, and there is no doubt that particular types of machines will be developed as the outcome of evolution, just as we have various types of steam engines most suitable for either stationary purposes, locomotives or steamboats. But apart from structural details there are fundamental differences between a dynamo and a motor. In a dynamo, mechanical energy is converted into electrical energy by the movement of the wires on the armature between the field magnet poles, cutting the magnetic lines of force. By the passage of the current through these wire coils of the armature the iron core of the latter is polarised and the direction of rotation is such as if the poles of the armature were continually approaching poles of the field magnets of the *same sign*, and receding from those of *opposite sign*.

There is a magnetic repulsion in one direction which has to be overcome by mechanical power which pulls in the opposite direction ; at the same time the poles of the field magnets are weakened by induction through the similar poles of the armature, which are somewhat nearer than the dissimilar poles owing to the diameter of commutation. This circumstance, however, does not interfere with the *efficiency* of the dynamo, but it involves heavy and powerful field magnets, in order to overcome these opposing effects.

With motors the case is somewhat different, since the mechanical effect is obtained more by the magnetic attraction between poles of opposite signs than by repulsion, consequently the magnetic induction between two sets of poles tends to strengthen both, and it is not necessary to use such heavy field magnets for motors as for dynamos.

The reaction in a motor is *not* the same as the reaction in a dynamo. But apart from considerations of this nature, there are more important reasons why a locomotive motor requires an entirely distinct study, and these reasons are of a purely mechanical nature.

A tramcar motor or a boat motor must be of small dimensions, and it must be of the smallest weight compatible with a reasonable efficiency. For instance, a motor may be constructed to give 80 or 90 per cent. efficiency, but it may be so heavy that 20 per cent. of its power will be wasted in propelling its own weight. In this case it would be economy to use a motor of half that weight, and which will only yield 75 per cent. in mechanical power of the electric energy supplied to it. In the case of street cars, it takes 8 foot pounds of work per minute to move one pound weight at the rate of 7 miles an hour on the level road; 16 foot pounds to propel one pound up an incline of 1 in 75, and 24 foot pounds up an incline of 1 in 37 for every pound weight carried at the same speed. It is quite possible to make a 6 H.P. motor, weighing say 800 lbs., to give 80 per cent. efficiency; this machine, on an ordinary tramcar, would absorb 11·6 H.P. per hour for its own propulsion on the level; but it will be found that an equally powerful motor of half that weight, and of less efficiency, will be preferable.

The lighter motor will also occupy less space, and this, also, is an important point, especially with electric cars, where the propelling apparatus has to be placed underneath the floor, and where it is undesirable to materially raise the body of the car. Although the floor of a car may be 26 inches above the roadway, we can only allow about 16 inches for the height of the motor with its supporting platform, so as to keep a good clearance below, and 2 or 3 inches above the machine. The length and width of the tramcar motor will depend upon the dimensions and the position occupied by the gearing used for the transmission of motion from the motor spindle to the driving axle. There is a lack of space on every side, which becomes all the more apparent when we come to consider points of convenience, such as facilities for reaching parts of the mechanism which require occasional adjustment or repairs.

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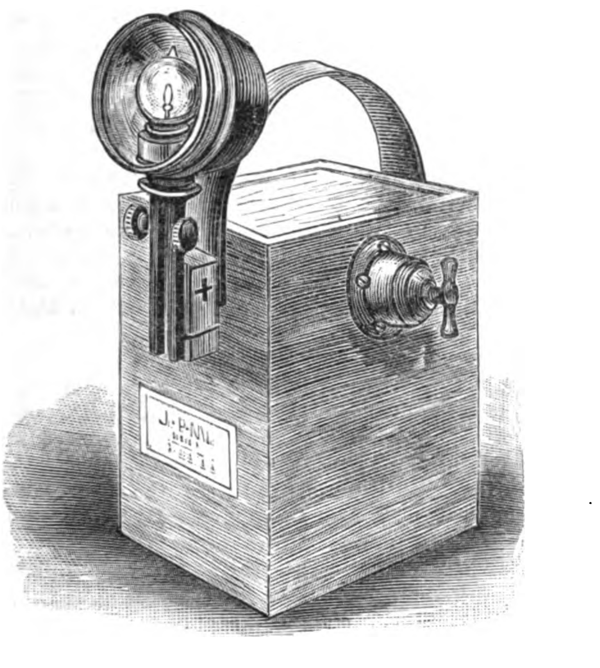
Electric locomotion is becoming a distinct branch of electrical engineering, and it involves a thorough knowledge of mechanical engineering. Numerous structural details have to be worked out, and there is a large scope for those who are experienced in electrical science as well as in the principles of applied mechanics.

The problem of the speed-reducing gear will be found the most difficult, although it may appear simple at first sight, but before entering upon a discussion of the gearing we have to clear up a few more details concerning motors.

PORTABLE ELECTRIC HAND LAMP.

THE portable electric hand lamp, of which we give an illustration, is the neatest of the kind we have yet seen. The apparatus consists of a small teak box containing 3 small accumulators, with a switch at the side for turning the current on and off. An incandescence lamp placed in the focus of a highly-polished parabolic reflector provided with a glass front, is arranged as shown. A leather strap is fixed on the upper portion



of the box, and serves as a handle to carry the apparatus about. The accumulators when charged will give a continuous light for 10 hours. The general make of the lamp is substantial, and there is practically nothing likely to get out of order, if the same is handled with reasonable care. The whole apparatus (which is patented) is designed and manufactured by Mr. J. Pitkin, the well-known aneroid barometer maker, of London.

A New Use for Electricity.—Mr. W. Thomson, F.R.S., uses electricity as a method of determining the relative degrees of stiffness of flour or of starch, pastes, or jelly. The method he proposes (after making many experiments) is to allow a spindle of iron 10 inches long to fall a distance of 12 inches into the paste, and then to measure with a rule the distance to which the spindle penetrated the paste. The spindle was supported by being attached to an electro-magnet, and when it hung from the magnet quite steadily the current of electricity was broken, the magnet lost its magnetism, and the spindle fell. By this means exactly the same momentum can be given to the spindle on its arrival at the surface of the paste; and, considering the nature of starch pastes, the results obtained were satisfactory.

NOTES.

Opening of the National Gallery after Nightfall.—A Parliamentary return just issued gives the opinions of the trustees and director of the National Gallery upon the question of keeping open that institution after nightfall. Those opinions are adverse, and one of the objections relates to the lighting of the gallery, the document stating that "of the several known means of artificial lighting only two are practicable in public buildings—gas and electricity. The objections to the use of the former in picture galleries are too manifest to be disputed. As to electric lighting, the science of which is in its infancy, proof is as yet wanting that it contains no elements or involves no conditions likely to affect such sensitive works of art as pictures; nor, even could it be shown to be harmless in that respect, has it been brought so fully under control as to afford security against all danger of fire on the one hand, or of sudden extinction on the other. Were the light to collapse (an event of common occurrence) much panic and disorder might ensue, with risk of accidental or even wilful injury, before the rooms could be cleared." There is absolutely no ground for the very ridiculous statements in this document with regard to the electric light. It is not a fact that no proof exists as to its harmless effect upon pictures; it is untrue that it cannot be so controlled as to avoid the danger of fire or sudden extinction; and the statement is utterly false that a collapse is an event of common occurrence.

Ship Lighting.—On Friday last Messrs. Napier, Shanks and Bell, Yoker, Glasgow, launched a handsome steel promenade-decked paddle steamer named the *Ozone*, built for the Bay Excursion Company of Melbourne, and specially designed for passenger service on Hobson's Bay. Her general arrangements resemble those of the best Clyde passenger steamers, with special modifications and improvements to suit the intended traffic. The vessel throughout will be fitted with the electric light.

On Saturday the Barrow Shipbuilding Company launched the twin torpedo cruiser *Fearless*, of the Scout class, built for the Admiralty. The torpedo armament will consist of eleven torpedo tubes or air guns. Electric search lights and other modern improvements are to be supplied.

The other day there was launched from their Leven Shipyard by Messrs. William Denny and Brothers a steel screw steamer of about 5,200 tons gross, named the *Jumna*. This steamer has been built for the eastern trade, and the electric light will be fitted throughout by the builders themselves, and will be provided not merely for the passengers' accommodation, but also for the machinery departments and the officers and crew.

Some time ago, the London and Edinburgh Shipping Company issued specifications for the lighting by electricity of its steamer *Malvina*, and the estimates submitted by Henry Bennett & Co., Glasgow, were accepted. The installation consists of an "Andrew's" patent dynamo 68 20-C.P. lamps, and one of Tangye's "Soho" engines. The lighting has been divided into four circuits, controlling respectively the saloon, second cabin, engine-room, and holds. The steamer has been fitted throughout on the "single wire system," and the result has proved highly satisfactory. Messrs. Bennett, we believe, have several other important contracts on hand.

Hotel Lighting Abroad.—The Windsor Hotel, New York, is now beautifully lighted by a 500-light installation, on the Westinghouse system. The vestibules are illuminated by single lamps of 150 candle-power each.

Lighting Literature.—*Modern Light*, a journal devoted to coal gas and petroleum interests, electric lighting and kindred methods of illumination, made its first appearance in January at Boston U.S.A.

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The Lighting of the Theatre Francais.—A Paris correspondent writes : The electric light is going to be tried at the Théâtre Français, in the hope that it may be permanently used instead of gas. Should it succeed, the expectation is that the summer and early autumn seasons will be more profitable to the company than they hitherto have been. A gas-lighted theatre is an oven in summer, and at all times of the year the inner heat causes such rushes of cold air from without whenever a door is opened that playgoers who have not throats and lungs able to resist any sudden change of temperature risk their lives.

Electric Lighting in Vienna.—*Gas and Water* says: "The electric light has received a severe check in Vienna. A great many arrangements between the electricians and the Town Council were cut and dry ; but the higher authorities have intervened, and direct that, since the electric light is in nothing more than an experimental stage, and since it is neither the duty nor within the competence of the town authorities to risk the public money in encouraging the electric light, the arrangements in question shall go no further. Private consumers may, as they please, make their own bargains with the electricians."

Electric Lighting in Rouen.—Electric lighting is to be charged at Rouen, according to the proposed scheme there, at the following rates :—A group of three lamps of 54 candles each, 3d. per hour ; a group of four lamps of 45 candles each, 2½d. per hour ; a group of five lamps of 13½ candles each, 2d. per hour ; not less than 1,000 hours per annum to be charged. A prime charge of £6 for fitting up and renewals of one group. There are some anomalies in this scheme, remarks *Gas and Water* ; the second mode of grouping is, for instance, decidedly the cheapest—too cheap, one would say, to be remunerative, for electric light, that is to say.

Maxim-Weston Electric Company.—The secretary writes as follows :—"This company has just received a most satisfactory report regarding their latest foreign installation, which includes the lighting of the entire surface works of one of the largest mining companies in South America. The manager of the company in question has written regarding the light as follows :— 'I am pleased to report that your two electrical installations have so far given the greatest satisfaction. Since starting a month ago we have run these all night without the slightest hitch, and the light has effected a great saving by preventing theft, it being possible for one watchman to see what is going on at the furthest extremity of the mill. The wiring of one of the shafts will be complete in a week or two, and I have no doubt will prove equally successful.'" The secretary states that the company has received several large home and foreign orders during the present month, and that they hope to be in possession of and in full operation at the new works they have taken by the end of next month.

Navigation by Electric Light.—Lloyd's sub-agent at Ismailia, under date March 23rd, 9.50 a.m., telegraphs that the *Carthage*, lighted by electricity, left Port Said on the 22nd at 8 p.m. and arrived at Ismailia at 5 a.m., the trip being very successful.

Fatal Fall from an Electric Light Tower.—An accident in Detroit proved the aptness of the statement made before the Electric Light Convention by Mr. C. J. H. Woodbury, to the effect that a "lineman is in infinitely greater danger from gravity than from electricity." One of the trimmers fell from the top of a Detroit electric light tower, the fall of 140 feet killing him instantly.

The Telegraph in Asia.—The *Times* correspondent, at Tientsin, telegraphed, on February 27th, that : "There is a report (which needs confirmation) that an arrangement has been made between the Governments of China and Russia to connect Pekin and Kiakhta by telegraph."

Registered Telegraphic Addresses.—In answer to Mr. D. Smith, in the House of Commons, on Tuesday, Mr. H. Fowler said : There are, the Postmaster-General tells me, several objections to the official publication of a list of registered telegraphic addresses, the chief among them being that inconvenience to the public would arise from messages being addressed to names which, although appearing in a periodical list, had ceased to be registered. Numerous alterations, I should explain, take place in the register every day, some names being altered and others withdrawn. I may add that certain persons strongly object to the publication of their registered addresses.

Amongst the notices of questions for Thursday evening, in the House of Commons, were the following :—By Mr. Seton-Karr : Whether the Post-office authorities can adopt some means to prevent the payment of fees for valueless and inoperative abbreviated telegraphic addresses. By Mr. Labouchere : As to the expediency of reducing the fee now charged for registered telegraphic addresses in provincial towns to one-half.

Telephonic.—The National Telephone Company has rented almost the whole of the underflats of the Royal Exchange, Glasgow, for its telephone exchange.

The Telephone as a Fire Alarm.—Another instance of the value of the telephone is to be noted in connection with the recent alarming fire at Lemberg. The fire originated at five o'clock in the morning, and immediately on its discovery the alarm was telephoned to the fire brigade, who arrived on the spot in time to save the building. The advantages of the telephone system were so apparent that the Mayor of the town directed the superintendent of the exchange to call upon him with the view to its extension. This exchange, as well as many others throughout Austria, is worked by the Telephone Company of Austria, Limited, a subsidiary of the Consolidated Telephone Construction and Maintenance Company.

A Direct Wire to Australia.—Sir T. M'Ilwraith has been expressing his astonishment that the Queensland Legislative Assembly should tolerate a "monstrous" charge of 10s. 10d. a word exacted by the telegraph companies, with the permission of the Telegraph Conference at Berlin. To overcome the monopoly he advocates the construction of a direct line from Australia to England, all the colonies combining to carry it out.

Cremating by Electricity.—In these days of enterprise and innovation it does not do to be surprised at anything new ; but the following scheme is somewhat uncanny and blood-curdling. It is proposed to adapt electricity to an entirely new use, namely, to cremation. At present details are scanty, and, while cremation by fire is not allowed, it is perhaps early in the day to talk of employing electricity for that purpose. The process is as follows :—The body being shrouded in sheets made of asbestos, is laid upon a frame composed of fire-brick, while at the head and foot are large copper plates, to which the leads from specially-constructed dynamos of large electromotive force are attached. The body apparently occupies the position of the filament in an incandescent lamp, and, upon the current being passed through it, would be instantly carbonised ; while, as the air would have free access to it, the process of destruction, or rather decomposition, would be immediate. This process appears to have the recommendation of great rapidity of action, and freedom from many of the objections to cremation in the ordinary way, and admits of several little improvements upon all recognised forms of burial ; it might be so arranged that the next of kin or the chief mourner should with his own hand press the knob sending the current through the body, and thus have the melancholy satisfaction of performing the last sad rites. We do not know the inventor's name.

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The Telephone and Rifle Shooting.—Some experiments have recently been made near Portsmouth with the view of ascertaining the utility of establishing telephonic communication with the "markers" at rifle shooting matches. The trials which have been made at Browndown appear to have been of such a highly satisfactory character, that it is probable that the system will be generally introduced at the targets there. The *modus operandi* is as follows:—Wires are laid on posts at a distance of about four feet from the ground, and extend along the ranges from end to end. These would be of a permanent nature, but the telephones are extremely small, and are of very much the same pattern as those used on board Her Majesty's ships for diving purposes. The operators wear a kind of elastic cap, to which are affixed the telephones; and, of course, this apparatus can be attached or detached at pleasure. The "marker" behind the butts, and the officer in charge of the firing party, might thus be in direct communication with each other, and to the latter might be communicated almost instantaneously the result of each shot, while the "marker" could receive his directions without the least trouble.

The Watt and the Joule Practical Electric Units.—Mr. Desmond FitzGerald writes to the *Engineer* to correct an error of terminology in Mr. Kapp's article on "Testing the Commercial Efficiency of Dynamo Machines." Mr. Kapp says, since the unit of current is 10 ampères, and the unit of electromotive force 10^{-8} volts, and since the product of the two must be equal to the erg, we find that one watt equals 10^7 ergs. Mr. FitzGerald says: Now, the product of 10 ampères into 10^{-8} volt is correctly $\frac{1 \text{ erg}}{\text{time in seconds}}$, or one absolute electro-magnetic unit of power on the C.G.S. system—a unit which has not received a name. The volt-ampère or watt, which is the practical electric unit of power, or $\frac{\text{work}}{\text{time}}$ is, therefore, $\frac{10^7 \text{ ergs}}{\text{time in seconds}}$. It is the volt-ampère second, or joule, *i.e.*, the practical electric unit of work, which is equal to 10^7 ergs. Electrical work is very commonly expressed in watt-hours, and thus the joule or $\frac{\text{watt hour}}{3600}$ is a unit not often used. The distinction between power and work is so often lost sight of that the present correction may be of value to some of your electrical readers.

Drop-Forged Copper.—Mr. C. E. Billings, of Billings and Spencer Co., of Hartford, Conn., after a great deal of patient experimentation has succeeded, says the *Scientific American*, in producing drop-forgings in copper. Pure copper connectors, screws, and other parts of electrical apparatus have hitherto been unobtainable, owing to the difficulties experienced in casting copper.. It has been the practice to add to the copper a small proportion of tin to insure a homogeneous and smooth casting, but the tin interferes with the conductivity of the metal; its presence is therefore undesirable. Mr. Billings's efforts will be appreciated by manufacturers and users of electrical apparatus.

Galvanic and Magnetic Appliances.—A correspondent writes:—"Is magnetism, as represented by Mr. Lamont's appliances, as compared with electricity in the form used in the 'Pall Mall Electric Association's' Electropathic Belts—and more especially their Medical Battery Belts—the quicker curative agent in nervous debility and other nervous disorders." Our editorial sufferings have not yet led us to experiment with any of the apparatus above-mentioned, but we are of the opinion that, "kill or cure," the galvanic appliances would be the more efficacious.

Secondary Batteries as Regulators.—We have received a communication from Mr. R. Percy Sellon on this subject, too late, however, for insertion in our present issue.

To be Let.—We noticed the following in the *Standard* this week:—

"Colchester (near to); only 1½ hour's train from London.—To be let, Berechurch Hall, a handsomely furnished modern mansion, containing about 30 bed and dressing rooms, fine reception rooms, spacious offices, and extensive stabling, all lit by electricity; with capital shooting over the manor of about 3,250 acres.—Apply to Messrs. Daniel Smith, Son, and Oakley, land agents and surveyors, 10, Waterloo Place, Pall Mall, S.W."

Our readers may probably call to mind the letters of Mr. Octavius Coope which were published from time to time in the columns of our leading "daily," on the lighting of Berechurch Hall.

The Edinburgh Exhibition.—The members of the Edinburgh Architectural Association paid a visit on Saturday afternoon to the exhibition buildings on the West Meadows. Mr. W. A. Bryson, Edinburgh, explained the system of electric lighting. In the main avenue, he mentioned, there would be 1,444 incandescent lamps of 20 candle-power each. The permanent building will be lighted with 150 arc lamps, and in front of the main entrance there will be other six arc lamps. On the northern promenade there will be 32 arc lamps, each of 2,000 candle-power, and suspended from eight masts 50 feet in height. The ornamental lighting will be obtained from 1,200 incandescent lamps coloured red, blue, and yellow, each of 10 candle-power, and these lights will be festooned in rows from Venetian masts. Old Edinburgh will be illuminated by 250 incandescent lamps; and in the machinery section there will be 32 arc lamps of 2,000 candle-power each. Incandescent lamps will be fitted round the band stands and refreshment rooms; and the lighting of the whole of the buildings and grounds will be effected instantaneously.

Electric Locomotion.—The article which we publish this week from the pen of Mr. Reckenzaun opens up what might be an important discussion as to why a motor should be *different* from a dynamo; lately a good deal has been said to show that the two machines should be identical. The opponents of the latter theory might reasonably be expected to say that centrifugal pumps and turbines are *identical.*

Improved Battery Cells.—We have received from Messrs. Gent & Co. one of their new patent insulated Leclanché cells, in which, they claim, the battery salts are prevented from creeping. Lead tops to the carbons are done away with, the terminals being embedded in the carbon itself. We shall hope to give an illustration of the new cell in our next.

The Reviewer and the Reviewed.—Professor Silvanus Thompson's latest edition of "Dynamo Electric Machinery," has recently been reviewed in the columns of a contemporary. Some correspondence has taken place between the Professor and the Reviewer, and the former last week clinched his arguments by the following hostile paragraph:—"If he will ask me to show him how the curved sole of my boot can be placed approximately parallel to the horizontal plane, I shall be happy to oblige him." We opine that if the Reviewer be the man we suspect, such conduct on the part of the Professor would result in the latter suddenly assuming a horizontal position with relation to the earth's surface, and with a velocity far exceeding that due to the accelerating effect of gravity.

Electricity is "Life."—A professor in a college asked a student one day what electricity was. The student hesitated, and tried to think of the correct answer, but in vain; it was no use. He could not recall it, but in self-defence said, "I did know, but have forgotten." The professor replied, "This is terrible. The only man who ever knew what electricity was has forgotten!"

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Photography by Lightning.—Mr. Albert S. Barker, of Philadelphia, has succeeded in taking two very fair photographic negatives of outside objects by utilising the light furnished by a flash of lightning. Mr. Barker developed the plates the same evening. From their behaviour he estimated the actinic effect of the light was equal to that obtained from an exposure of about 1-300th part of a second in bright sunlight. The very significant fact observed by Mr. Barker in his photographs, that the foliage taken shows unmistakable evidence of having perceptibly moved during the period of exposure, demonstrates that the lightning flash was by no means instantaneous.

Electrical Fountain. — American contemporaries state that Sir Francis Bolton has made a contract with Mr. Erastus Wiman for the sale of patents and rights of exhibition in the United States of his electrical fountain. The fountain will be one of the features of the Staten Island Amusement Company during the coming summer.

Fatal Carelessness.—As Hugh Oliver, aged 23, an employé of the Evansville, Ind., Electric Light Company, was at work replacing a screw on the arc dynamo with his right hand last month the screw slipped, and the man, in endeavouring to catch it, placed his left hand also on the dynamo. The current passed through his body, killing him instantly.

Oh, you are, you are!—For arriving at the true meaning of the above expressive exclamation we must refer our readers to a breach of promise case which appeared in the daily papers of Thursday. One of the parties specially interested therein is well known to the electrical profession.

Self-Induction.—We believe that our readers generally were much gratified in perusing the masterly paper read by Professor Hughes before the Society of Telegraph Engineers and Electricians as his inaugural address. The article which we publish this week on the same subject contains much to interest both the scientist and the general reader.

Incandescent Lamp Tests.—Messrs. Woodhouse and Rawson have once more gone into the question of the incandescent lamp tests made by the Franklin Institute. Their letter, however, is entirely misconceived, that which Mr. Tatham stated being perfectly correct. In no portion of the report of the Committee do Messrs. Woodhouse & Rawson figure as contestants, and the manner in which the committee became possessed of certain of their lamps was, as we have before insisted upon, fully and clearly set forth. We sympathise with these gentlemen, but their attack upon the Franklin Institute is entirely misdirected. The testing committee simply performed a duty which certainly did not include an enquiry into the right which a certain company had to enter another firm's lamps.

Electric Lighting by Secondary Generators.—The description of the central station lighting in the City of Tours which we place before our subscribers this week is very interesting. Although we believe that similar work is being carried on in this country not 100 miles from the West-end of London, information thereon is not easy to obtain.

The Uses of Secondary Batteries.—The letter addressed by Sir William Thomson to the Electrical Power Storage Company, a copy of which appears in our "Correspondence" column, is an important testimony to the value of secondary batteries.

Proposed New Cables.—The *Echo* states that the Agent-General for New Zealand has received several offers to lay a cable from Australia to New Zealand, along the existing route. The lowest offer is for £150,000. The intelligence has been sent to the New South Wales Government, with an inquiry as to whether they are prepared to entertain the proposal.

The Light Obtained from Incandescent Filaments.—According to *Engineering*, Mr. Bernstein finds from observation made on a number of lamps that the amount of light obtained from an incandescent lamp increases with the third power of the number of watts used; or, expressing this in a different way, the amount of light obtained from carbon at different stages of incandescence increases as the third power of the total energy radiated from the carbon. If λ is the amount of light emitted, measured in standard candles, V A the number of watts required for producing λ, then

$$\frac{V A^3}{\lambda} = K,$$

in which K has a constant value peculiar to every lamp. It is often useful to know at what candle-power a lamp will work at an expenditure of say n watts per candle, and from this formula we have $V A = n \lambda$, and on substituting this value for V A in the above equation, we have $\lambda = \sqrt{\frac{K}{n^3}}$. The constant K can be determined by making one single measurement at any arbitrary candle-power. The formula may also be put thus: $K = \frac{(C^2 R)^3}{\lambda}$. Within certain limits the resistance of a lamp changes very slightly, and may be considered constant. Therefore it appears that within these limits the quantity of light varies as the sixth power of the current, a fact observed by Mr. Preece and Mr. Kittler. The value of K given by Mr. Bernstein is constant only up to a certain state of incandescence, and is then subject to variations which seem to depend on the style of the lamp. At first the value of K is slightly higher, but it soon reaches a minimum, and then remains practically constant up to a candle-power largely in excess of the normal. The growing increase in the values of K at the highest incandescence may be supposed to be due to a change in the relationship between the energy and light at the highest state of incandescence of the carbon, or that losses of electric energy occur inside the lamp. In the last case the measured value of V A would be in excess of the energy radiated from the carbon, thereby producing an increase in the value of K. M. Bernstein is of opinion that such losses do occur.

Electric Guns.—Messrs. W. H. Reynolds and C. S. Seyton, of 31, Lombard Street, London, have for the inspection of those interested in such matters some specimens of double-barrelled guns and army rifles, altered to the new system of firing by electricity (Russell's patents). Very exhaustive tests, tending to show the superiority of the electric system over that of percussion, have been made in the United States, where the new method is said to be very rapidly coming into favour with sportsmen, and also with officers of the army. The advantages claimed for the system are numerous. The small battery (about 6 inches long and an inch in diameter) and its simple connections render unnecessary the complicated lock required in percussion, and its use would, it is believed, result in great economy in the production of new weapons; while the alteration of the existing small arms from percussion to electric fire is easily and inexpensively made. The change in the shell for use in the electric system, by the substitution of the igniter for the percussion cap, is made at small cost, and as the igniter is not destroyed or displaced by repeated firing, it has been found to have, practically, the life of the shell. By dispensing with the use of fulminate employed in the ordinary cap absolute safety is secured, and the risk in transporting and handling cartridges is also done away with. Perfection in the making of the present cap can only be proved by its explosion, whereas each igniter can be tested before the shell is loaded; and as the igniter can be extended any distance into the shell the powder is lighted over a larger area, the entire charge is more completely burned, and more force to the explosion secured. The mechanical force employed in pulling the trigger in existing arms is a cause of inaccuracy in aim, which

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by this system is wholly done away with. It is well known that the firing of the fulminate in the cap is injurious to the chamber and barrel by reason of its corrosive effect; this is wholly avoided by the use of electricity. The life of the shell is considerably lengthened by the avoidance of the strain caused by the expansive force of fulminate, and the necessity of reforming the shell for repeated use is lessened. The generator or battery is simple, solid in construction, and conveniently placed in the butt of the gun. From actual experience, as many as 15,000 ignitions have been obtained from one battery, without any change of the elements, and extreme alternations of temperature seem to have no effect on its efficiency. An average of 5,000 to 7,000 is therefore considered a safe estimate of the number of shots that can be fired from an electric gun or rifle without change of battery. The conditions of economy, perfection of fire, and safety in the use and transportation of guns and ammunition are specially called for in military weapons, and it is claimed that all these benefits have been attained in the Russell electric gun.

Lecture.—Mr. Wm. Lant Carpenter, B.A., B.Sc., delivered the fifth of the course of lectures for the people, under the auspices of the Yorkshire Union of Mechanics' Institutes, at Skipton, last week. His subject was "Electrical Energy and Its Uses." There was a large audience, and great interest was manifested in the experiments and illustrations. The lecturer explained what was meant by energy. Electrical energy was usually obtained from the energy of chemical action or from mechanical energy. The manner in which electric light is developed from mechanical energy was shown, and the lecturer detailed the advantages of that form of illumination.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Swansea Telephone Exchange Company, Limited.—The annual return of this company made up to the 19th ult. was filed on the 20th inst. The nominal capital is £5,000 in £10 shares, the whole of which have been taken up. Upon 21 shares the full amount has been called, and £9 per share upon the remaining 479 shares. The calls paid amount to £4,477 8s. 9d., leaving £43 11s. 3d. unpaid.

Chelsea Electricity Supply Company, Limited.—The annual return of this company, made up to the 16th inst., was filed on the 18th inst. The nominal capital is £100,500 divided into 20,000 shares of £5 each and 500 shares of £1 each; 150 of the £5 shares have been taken up and the full amount has been called thereon. The calls paid amount to £725, leaving £25 unpaid. Registered office, Draycott Place, Cadogan Street, S.W.

CITY NOTES, REPORTS, MEETINGS, &c.

Swan United Electric Light Company, Limited.

THE adjourned third ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Tuesday, when Mr. J. S. Forbes, chairman of the company, presided. The annual report of the directors presented to the meeting was as follows:—

The shareholders are aware that the company is engaged in litigation with the German Edison Company and with the Continental Edison Company which control the Edison patents in Austro-Hungary, Belgium, France, Russia, Spain, &c. Believing it to be for the interest of all concerned that this litigation should be brought to an end, the directors have spared no effort to arrive at some fair and equitable settlement with the Edison companies on the Continent. Negotiations have been carried on with this end in view; those with the Continental Edison Company are still in progress, but it seems as if in Germany the suits must be fought out. It will be seen on reference to the last balance sheet that the loss which had accrued up to 30th June, 1884, amounted to £2,327 7s. 9d., to which must be added, that on closing Paris factory in 1884, £1,128 14s. 8d., and by the fire at Lille, £1,094 2s. 11d. The loss during the year ending 30th of June, 1885, as shown by the profit and loss account, amounts to £6,258 9s. 7d., which added to previous loss brings the total up to 30th June, 1885, to £10,808 14s. 11d. The Lille and Cologne factories were not in working order until the spring of 1885. During the end of 1884 and the early part of 1885 the company had to purchase lamps to supply their customers. In spite of legal proceedings and most active rivalry the business of the company improved in the quarter ending 30th September, and shows a favourable balance of £3,206 0s. 5d., thus reducing the amount standing at debit of profit and loss at that date to to £7,602 14s. 6d. Heretofore the accounts have been made up to 30th June in each year, the directors propose that the financial year shall in future end on 30th September, and for that reason they now present the accounts to the shareholders for 15 months. The question of the distribution to the shareholders of the shares allocated to this company in the Edison and Swan Company has received the most careful consideration of the directors, but they find that such distribution cannot take place pending the legal difficulties before referred to.

Major Flood Page, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, remarked that in the initiation of the company great mistakes were made, too much was paid for the patents, and they entered upon a business of which they were not masters. The first duty of the Board of the Edison and Swan United Company had been to thoroughly bottom the affair, and make up their minds to carry on the business in future on a sound basis. They were able to come forward at the end of the first year and show the proprietors that instead of landing them in a heavy loss of £28,000 as in the previous year they had made a profit of £12,000; that profit they did not distribute, but carried to reserve. Exactly the same thing had occurred in this company. The accounts as they stood revealed not a very satisfactory state of things, it revealed a considerable loss on the working of the foreign business. The accounts were made out to June 30th, for, as they no doubt remembered, the meeting had been adjourned from time to time in order that they might have the opportunity of doing abroad what they had done at home, put the horses of the two companies together and get rid of the loss and cost of legal proceedings, and also to get rid of the terrible obstruction to business which was always attendant upon litigation about patents. Their efforts had not been wholly successful, and on the other hand they had not been unattended with some encouraging results. They had two combinations of people to deal with. Mr. Edison or his friends sold his patents, some to a German combination having its seat in Berlin, and some to a combination in Paris which controlled France, Italy, Austria, and some other countries. With respect to the Berlin business, they were in more active competition there with the Edison people than in any other place, and litigation was still pending. They had there, as in England, the very best advice which it was possible to get; they were advised that their patents were not infringements of Edison's, but were self-standing. Of course the other side said they were infringements and must be "injuncted," and they were in that state of litigation that they were working practically with an injunction round their necks. They were told, notwithstanding that, that they would succeed. They thought they might impress their German competitors with the wisdom of what they had done in England; but they (the Germans) sought to impose terms so exceedingly unsatisfactory that they could not accept them, and relying upon the advice of experts they had now determined to await the issue of an appeal coming on on the 27th of this month against the judgment of an inferior court, which had gone against this company, in opposition to the advice of the Patent Office. As regards the combination in Germany therefore it looked as if the suits must be fought out. With respect to the other combination, they had had several interviews in Paris and London, and although he was not in a position to say that they had come to an agreement, they were within "measurable distance" of an agreement, that was to say they might think it worth their while to accept the terms which had been suggested to them as counter-terms to their own. They did not at present feel inclined to do so, and something would turn upon the result of the appeal in Germany; but there was a very good prospect of their being able to come to an arrangement with the Paris Edison Company. Another advantage of having deferred the meeting upon two occasions was, that they were enabled to bring down the statement of accounts to the end of the year. By referring to the profit and loss account they would see that on the one side of the account the stock on July 1st was £4,187; there was a total on that side of £32,484 4s. 1d. On the opposite side they would see sales, &c., less commission and allowances, transfer fees, interest, &c., stock on June 30th, 1885, the balance being loss, £6,258 9s. 7d. At first sight that looked rather startling, and if there were not some circumstances which would make it more or less palatable it would be very serious. But it so happened that in that particular year their business was entirely disarranged by the fire at Lille, at the factory which, by the French law, they were obliged to construct for the manufacture of lamps in order to maintain their patents. Another factory had been started at Kalk, near Cologne, in Germany, on precisely the same grounds. The Lille factory had barely got to work when it was burnt down, and the whole process of manufacture stopped for a considerable time, and they then had the rent on their backs, the taxes, the establishment, for they had got the people together with great difficulty and could not discharge them, as very few understood the process of manufacture, and it would be difficult to get them together again. Their large stock of lamps

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was destroyed with the factory, and in order to supply their customers they had to purchase lamps from the parent company, which, although affiliated to this company, did not consider it its duty to supply them with lamps at prime cost. They made a reasonable bargain with them and sold a large number of lamps at a considerable profit. Thus there were two items against them: they had to buy the lamps at a price beyond the ordinary cost of production, and their out-turn of the balance of lamps was very greatly increased by the fire at Lille, for it took a long time to get the output up to a figure which would make it profitable. That balance, however, was not so bad as it looked, because the stock on hand on June 30th, put down at £7,000, was estimated at the price of production, but, of course, they had been produced on the assumption that they would be sold, as they would be sooner or later. It would not be politic to bring into the credit of the account the selling price of the lamps, and they brought them in at cost price as an asset, the theory being that they were worth at any rate what they cost to produce, the fact being that they would probably realise considerably more; therefore, that £7,000 represented a saleable value of nearly twice as much, and that being so the loss would disappear. He wished them to think that out—that of necessity, when they made up their accounts they must have a large stock of lamps on hand, which meant wages, rates and material, material being an expensive item. All that had been expended, and came to the debit of the account. On the other side, they did not put in the profit in profit and loss, but merely the cost of production. That would probably bring them nearly to a balance; there would be no gain, but there would be no serious loss. At June 30th, 1885, they had £360,000 of capital represented by shares fully or partially paid. There was a small profit on cancelled shares, and there were sundry credit balances. On the other side there were patent rights, £104,000—awfully in excess of what ought to have been paid, but there it was. It was very easy to be wise after these periodical manias which seized the public when they were induced to give a great deal more for patents than the patents turned out to be worth. Then the next items were, outlay on factories, plant, furniture, &c., less depreciation, £7,548. Then the shares in the Edison and Swan Company, £208,478. Sundry debtors, £7,634; stock in hand, £7,110. Loan on security, £11,000, and cash in hand and at the bank, £8,000, made £19,000; balance from profit and loss account, £6,258, and loss from previous years, £2,327, showing a loss on the business of £8,585 up to June 30th, 1885. Added to that was the loss by the fire at the Lille factory, £1,094. French insurance companies managed to wriggle out of their obligations in a wonderful manner, and in this instance this company had thought it better to compromise and lose a considerable sum rather than get into litigation with the French company. They made up their minds that it was advisable to close the Paris factory, where there was a business but no profit, and accordingly they shut it up. In fact, they had been doing abroad what they had done at home with so much benefit to the Edison and Swan Company, they got rid as rapidly as possibly, and on the best terms possible, of bad bargains. That brought the loss in working to £10,800. That was not very satisfactory, but it was subject to two qualifications. First, he had pointed out that there was a tangible profit not brought to book at all—the selling price of the lamps as distinguished from their cost price; and the other point was that they had paid several thousand pounds for learning the pitfalls of the business. One had always to pay for that, and he and his colleagues thought they had had a very good get-out of the difficulties by which they had been surrounded. In consequence of the postponement of the meeting, hoping to have something tangible to report, they had availed themselves of the opportunity to bring down a profit and loss account to the end of the year, and they had printed a supplemental account to September 30th. They had increased the stock of lamps abroad at the two factories to 117,000, and the dead value lying upon those lamps was £10,234 upon a very moderate estimate indeed. By experience they had proved that in the year they sold a very large quantity of lamps at the average rate of 3s. 8d. each. They had carried into the balance 117,000 lamps at a shadow under the cost of production; they had taken them in at half the saleable price—rather under half, at 1s. 9d. If those lamps realised 3s. 6d., they would by the end of the realisation of the lamps have wiped out the whole of the loss they had incurred from the beginning, about £11,000. The future now turned upon this: had they touched bottom yet? They had learnt a great deal; they had got the means at their fingers' ends of diminishing the cost of output, because the greater the output, the less the proportion of the cost of the lamp; and they had a trade which was growing, less rapidly than they wished, but which would develop, they believed, with much greater rapidity once they got rid of litigation. The opinion of the directors was that the business was now as bad as it could be, but that they had in hand an asset quite sufficient to wipe off the loss on the business up to that moment, and that the probabilities were strongly in favour of their being able to go on and turn a present loss into a future profit. A paragraph in the report alluded to the proposal to alter the period of their financial year, so that it would terminate in future on September 30th. The reason of this proposed change was that they were enormously interested in the Edison and Swan Company, and that company would make up its accounts to June 30th, and hold its meeting between that date and September 30th, and, perhaps, at the next meeting, though he did not know such would be the case, a dividend might be declared, in which case this company would stand in for a very large percentage of it. They could not state their position without bringing into the credit of the accounts the results of the working of the British Company. Another paragraph of the report referred to the distribution of the shares allotted to this company in the Edison and Swan Company. The directors were very anxious to be relieved of the enormous responsibility of holding those shares in trust, but there were great difficulties in the way of their distribution at present. They could not distribute them at once without involving themselves in a question of considerable gravity, and the shareholders must again be good enough to rely on the judgment of the board and its solicitors, for it was much better to let the matter stand where it was at present. He concluded by moving the adoption of the report.

Mr. F. R. Leyland, the deputy-chairman, seconded the resolution, and said that it would be in the recollection of the shareholders that at the last meeting considerable anxiety was expressed as to the unsatisfactory accounts then laid before them, and, to a great extent, in consequence of that the two retiring directors were not re-elected and two new directors were put on the board. Of those two new directors he was one, and, judging from what took place at the meeting, it was for them, in concert with the board, at once to direct their attention to the state of the accounts, and also to the possibility of making the division of the shares in the Swan-Edison Company in England. Mr. Leyland, in continuation of his remarks, recapitulated the items to which the chairman had drawn attention as causing the loss, the principal one being the fire at Lille. He said it was quite clear the business was a profitable one; but the whole thing depended upon the result of the litigation, upon whether they could maintain their patents or not. With regard to the division of the shares, he did not see how they could carry out the distribution so long as the litigation, to which reference had been made, was pending. Litigation meant damages, damages in Germany, in France, in Belgium, in Austro-Hungary; and they did not know what those damages would be. When the litigation was at an end of course they could divide the shares, but then there would come to be considered by the shareholders some questions as to the desirability of such a division. There was a question as to the different positions occupied by the fully paid shares, and those only partly paid; there would be the question whether the shares should be brought to the same level, and, if so, whether it was worth while to pay the difference between the fully paid and the partly paid in order to get the Edison and Swan shares divided.

Mr. Foster criticised some points in the accounts and the manner in which a profit on the working of the last three months had been shown, but as he was not present during the earlier part of the proceedings the Chairman explained the matter to him, whereupon he withdrew his opposition.

A Shareholder asked was the Woodhouse and Rawson business finished.

The Chairman said the case was to be heard on May 4th. It had been postponed at the request of the defendants from time to time. Mr. Woodhouse had been very ill and obliged to go abroad. This company had been ready to go on for a long time, but on one pretext and another the matter had been postponed.

The motion for the adoption of the report was then carried unanimously, and the retiring directors, Mr. J. W. Swan and Mr. C. H. Stearn, and the auditors, Messrs. Quilter, Ball & Co., were re-elected, a vote of thanks to the Chairman bringing the proceedings to a close.

Direct Spanish Telegraph Company, Limited.

THE twenty-fifth ordinary general meeting was held at the offices of the company, Leadenhall Buildings, Leadenhall Street, on Tuesday, Sir James Anderson presiding.

Mr. Ch. Gerhardi, the Manager, having read the notice convening the meeting, and the report, which appeared in the REVIEW last week, having been taken as read,

The Chairman said he found that at the last meeting he dealt with what they did at the Telegraph Conference, and he referred also to their failure to get a line through Spain from Bilbao to Carthagena, and their failure also to get a good line from Madrid to Bilbao. That had been the object of this company for a great number of years. Now, he was happy to say, the proposal had at last met with the approval of the Cabinet in Spain for the first time; and, thanks to the good offices and friendly disposition of Sir Robert Morier and Sir Clare Ford, the late and present British Ambassadors, the Cabinet had put the thing in trim, and they were now likely to get a good wire established from Madrid to Bilbao. They (the directors) thought this would be a very considerable advantage to the company in improving the traffic; but, after all, speed had a great deal to do with it. Next, they were endeavouring to obtain an office in the bourse at Barcelona, which they had many reasons for supposing would make the service more reliable, and increase the traffic. Hitherto, strange divulging of messages had taken place in Spain, which they had been unable to trace or control, notwithstanding all sorts of efforts which they had made. The divulgence of bourse messages had induced the brokers to send fewer messages than they would otherwise send, and by getting an office in the bourse they hoped to end that trouble. The next thing in favour of their getting more traffic was the improving condition of Spanish trade. In these times of depression it was very gratifying to read in the *Times* that the exports for Spain in 1885 amounted to £40,000,000 sterling, "a figure which some years ago was assumed as the total of Spanish exports and imports."

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The fact was, Spanish trade seemed to be increasing. He had read somewhere that someone was coming to England to endeavour to bring about a *modus vivendi* with the Government here by which we shall enjoy the favoured nation clause commercially, which we have not hitherto enjoyed, on account of our alcoholic tariff. He believed we had always been ready to alter that as soon as they were ready to give us the same as Germany, France, and other nations. These were two hopeful signs of the company's future. Then he referred last meeting to the postponement of examining their old cable between here and Bilbao. The Eastern Company was not in a position to lend one of the smallest priced ships for that purpose, for, unfortunately, a ship had been lost. The Eastern Company had two ships coming home next month with their tanks empty, and he had proposed that one of these two ships should go into the Bay of Biscay, taking an independent engineer of the firm of Clark, Forde and Co., to pick up the cable and examine whether it was worth retaining as an asset or whether it would be cheaper to condemn it and reduce the capital. The other ship would go on to Falmouth, and would there be joined by one of Clark, Forde's partners, who would examine the cable in that part of the channel, and bring some of the cable home so that the directors might see with their own eyes and determine whether it should be retained or not. These things were being done. They still had to regret the reduction of the length of telegrams; they did not appear to have got yet to the bottom which merchants were striving to arrive at in the reduction of the telegrams and the combination of words to mean a great deal more than they ever contemplated when codes were introduced. They failed at the last convention to get that protected or altered; a resolution was passed by the tariff committee on two occasions, but it was rejected at full conference. Merchants had now five years during which to reduce as much as they could—and they could not blame them—and make telegrams as cheap as possible to themselves. But he was in hopes that with the reduced tariff to which they were coming, and the condensation already arrived at, they were not far off the bottom of both these things which were pulling against them. He was happy to say there was a small gleam of comfort in the fact that the traffic was improving. For the last quarter they had £500 to the good as compared with the same quarter of last year, and he saw no reason why the Spanish traffic should not be doubled; it was a ridiculous traffic for a great country like Spain, and he did not think they were anywhere near the end of their development of it. He was not inclined to take a pessimist view in this matter, and looked hopefully to the future. He moved that the report and accounts be received and adopted.

Mr. Edmund Etlinger seconded.

A Shareholder asked what would be the cost of a new cable.

The Chairman replied that they paid £60,000 for the last new cable, and he did not think they could possibly get it for less. Besides, he did not see any use for it. They had a joint purse arrangement with the Eastern Company, who had a cable to Vigo, on the same coast, and he did not think it would be wise to contemplate the laying of a new cable unless they saw their way to make it pay.

A Shareholder: Then what are we waiting for before we reduce our capital?

The Chairman: We have an asset which represents the capital of the company. A new cable has been laid by debentures, and the old cable represents the capital. If you lose that your capital is gone. You cannot do that without an examination to satisfy the shareholders that the assets are gone, or are not worth mending. It might be that a small amount would put the cable into working order.

Mr. Hughes-Hughes: Do I understand that any payment to the preference shareholders depends on the state of this old cable?

The Chairman said very largely it must. They had no reserve to speak of at present, and their assets were not properly protected. They could not decide upon what they should do in that respect until they decided whether they would reduce the capital or not.

Mr. Hughes-Hughes: I presume that will not be done without consulting the shareholders.

The Chairman: It will be put before you in the fullest manner, and you will have every opportunity of discussing it.

Mr. Cochrane criticised some of the items of expenditure, and objected to the company paying income tax when it had no income. He suggested the formation of a committee to confer with the directors upon the subject of the constitution of the directorate. There were two Eastern Company's directors on the board, and that, in his opinion, was too large a proportion of power in the hands of that company.

The Chairman stated that income tax was paid on the average of three years, and the third year would expire next year. Mr. Cochrane had favoured them at a good many meetings with objections to the Eastern Company for having two directors on the board, but he never proposed any substantive idea which would lead to a practical result.

Mr. Cochrane: My suggestion is for the appointment of a committee to arrange with the Eastern Company to sell this company to it.

The Chairman: But the Eastern Company will not buy it.—To his mind the assets of this company never represented the capital, of which there was too much. If they could bring about any reduction, with the consent of the preference shareholders, he would be only too happy to do it.

The resolution was then put and carried.

Sir James Anderson and Mr. John Denison Pender were re-elected directors, and Mr. Robert Duke, the auditor, was re-appointed, after which the meeting terminated with a vote of thanks to the chairman.

German Union Telegraph and Trust Company, Limited.

THE ordinary general meeting of this company was held at the offices, 50, Old Broad Street, on Monday, Sir James Anderson presiding.

The report of the directors stated that the total receipts during the twelve months amount to £10,930 11s. 7d., which, with a balance of £155 7s. 9d., brought forward from last account, make a total of £11,085 19s. 4d. The expenses for the same period amount to £823 12s. 3d., of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on the 20th January last, and the directors recommend the payment of a further dividend of 4s. 3d. per share, making a total distribution for the year of 10s. per share, free of income-tax, or at the rate of £5 per centum per annum (as against £5 12s. 6d. paid last year), leaving a balance of £12 7s. 1d. to be carried over to the next account. The diminished dividend in respect of the working of 1885 is attributable to the competition between the Atlantic Cable Companies, which has continued since the close of 1884, and especially so to the reduction of the tariff from 2s. to 1s. 8d. per word, which was introduced by the Commercial Cable Company. This reduction has not so far been compensated by any increase of telegraphic traffic with the United States. The loss on the Berlin Company's receipts would have been more considerable if the traffic between Germany and Great Britain had not shown a satisfactory increase. The renewal fund and reserve fund of the Berlin Company now amount to £58,000. The capital is £330,000. The cables are in good working order. The International Telegraph Conference, held in Berlin last year, has introduced reforms of great importance for European traffic. The agreement for the reduction of tariff between Great Britain and Austria and the countries beyond, which the Berlin Company accepted, has led to a satisfactory development of the traffic, and it is hoped that their receipts, by a further increase in this traffic, will not suffer any loss.

The Secretary having read the notice convening the meeting,

The Chairman stated that during the past year there had been a diminution of revenue, arising from the competition of the Atlantic Companies, and the reduction in their tariffs. The traffic between Great Britain and Germany, however, showed an increase. When they last met he expressed a hope that, at the Telegraph Conference then pending, a resolution would be passed limiting the use of code language. The matter was discussed on two occasions by the tariff committee, and a resolution was carried by a considerable majority to the effect that there should be an authorised code, using the dictionaries of eight languages. At the general conference meeting, held to confirm or re-discuss the matter, however, the motion was lost, and he regretted to find that the managers of the different telegraph companies in England were by no means unanimous as to the adoption of an authorised code or the adoption of dictionaries of the eight languages. The Post Office of the Indian authorities, and others besides, were against it, the main ground of their objection being that it would irritate their customers, the merchants. They now had five years to go on as they were, and he did not yet see the limit of the condensation system, though he supposed there was a point below which the messages could not be reduced. Happily, the use of telegraphy was growing, and therein lay the hope of the companies—in that and in the extended life of the cables. So far as the German Union was concerned, they were fairly well off, for they had a growing reserve. He concluded by moving the adoption of the report, and the payment of a dividend of 4s. 3d. per share, making 10s. for the year, or at the rate of 5 per cent. per annum.

Mr. H. G. Erichsen seconded the motion.

The Chairman, replying to questions, stated that nearly all the capital of the company was held in England, but Prince Bismarck had declined to allow it to be made an English company, and they could only remain agents for the Berlin Company. They had the right to all undirected German traffic, which was of substantial value.

The motion was carried unanimously, and a vote of thanks to the chairman and directors terminated the meeting.

National Company for the Distribution of Electricity by Secondary Generators, Limited.

THE third ordinary general meeting of this company was held, as announced in our last issue, at the offices, 18, Warwick Street, Regent Street, on Thursday last week, Mr. William D'Oyly presiding.

Mr. J. E. Pickering, the secretary, having read the notice convening the meeting,

The Chairman moved the adoption of the report and accounts, and called on Mr. J. Dixon Gibbs to second the motion, and give some account of the working of the company.

Mr. Gibbs, in seconding, said the business of the company generally was improving, and in many ways they had good promise for the future. The amount referred to in the accounts as having been received from the Banque d'Escompte for the year to February 1st last was only £1,087. That was the balance of 40,000

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francs, or £1,300, due for the year. For the year ending February 1st, 1887, there would be a minimum of 100,000 francs, or £4,000. With regard to the work done, the only addition worth noticing since the report was printed was the opening of a further portion of the Tours installation. The apparatus was ready and was going out for the Italian installations, which they expected to open in the course of the next month.

Mr. Kenneth Mackenzie inquired as to an item of £4,444 in the balance sheet relating to plant and machinery.

The Chairman replied that this sum included three dynamos, two of which had been sold, the generators used in the installation on the Metropolitan Railway, the workshops, tools, &c.

Mr. Mackenzie further inquired how the valuation of the plant was made.

The Chairman stated that the cost value had been reduced and taken off.

Mr. Gibbs added that the amount shown included the plant at Turin.

Mr. Glover remarked that £360 in the profit and loss account had been written off.

Mr. Mackenzie said the preliminary expenses were shown at £486, of which £54 had been written off. Had this amount any reference to the formation of the company, and if so, why was no more than £54 written off ?

The Chairman said the amount was in connection with the original formation of the company, and was a necessary expenditure. It could not all be written off in one year, and it was the proper practice to write off gradually.

The motion was then put and carried.

The Chairman moved that a dividend at the rate of 10 per cent. per annum be paid on the preferred shares.

Mr. Gustav Dufresne seconded, and the motion was agreed to.

Mr. D'Oyly and Sir James MacKenzie were re-elected directors, and the appointment of Mr. Dufresne to the board in the place of Mr. Le Fez was confirmed. Mr. J. H. Thornton, the auditor, was also re-elected.

A vote of thanks to the chairman and directors brought the proceedings to a close.

Electrical Power Storage Company, Limited.

At the ordinary general meeting of this company, held on Thursday, Sir Daniel Cooper moved the adoption of the directors' report, which states that during the years 1884 and 1885 the directors carried out a complete change of management both at the head office and at the Millwall works, and the result has been most satisfactory, for whereas up to the period of the change there was a considerable loss in the manufacturing business, the operations of the past year show a profit, which is steadily increasing.

To within a comparatively recent period, the company has had to contend not only against the universal depression and to the slow progress of the electric light industry, but also against the want of public knowledge of and confidence in secondary batteries, caused partly by the inexperience of users as to their manipulation and treatment, and also to the many imperfect and worthless batteries put upon the market; now, however, that it has been fully proved that batteries carefully manufactured under the patents of this company, and worked in accordance with the simple instructions given, are reliable and economical, and that they are indispensable to the success of electric lighting, and other purposes, their widespread adoption is to a certainty assured.

The only gold medal awarded for improvements in secondary batteries at the International Inventions Exhibition at South Kensington, was given to this company.

Many installations, both in private houses and offices, have been carried out successfully and at remunerative prices, and are giving entire satisfaction. Accumulators are being supplied throughout England, and a considerable number have been sent to the Continent, concerning the working of which the most gratifying reports have been received.

The company's accumulators are now in use at the Society of Arts, the South Kensington Museum, Admiralty, Royal Institution, Lloyd's, Bank of England, Peninsular and Oriental Company's Offices, Bank of New South Wales, Sir William Armstrong's, the Italian Navy, &c., &c., and are being supplied for the maintenance of upwards of 1,500 lights in connection with the lighting of one of the most extensive set of offices in London, the entire installation of which is being carried out by this company.

Besides the London, Brighton & South Coast Railway and the South Eastern Railway, where the cells continue to give every satisfaction, batteries have been supplied to some other of the principal railway companies in England, and on the Continent, in connection with various systems of train lighting, and the success of this important branch of the company's business is no longer a matter of doubt.

For private house lighting the absolute necessity of accumulators is now generally recognised, and it may safely be asserted that the majority of new installations now being carried out in England include accumulators—they are also being rapidly added to such existing installations as were erected without them.

During the past season the company did a large and increasing business in temporary lighting for balls and evening parties, and fresh plant for this class of work has been prepared for the coming season. Among the installations thus carried out may be especially mentioned those for the balls given by H.R.H. the Prince of Wales and by His Grace the Duke of Westminster.

By the employment of accumulators electric launches are now thoroughly reliable, and a considerable number will doubtless be in use during the next boating season. A launch has been lately built for His Grace the Duke of Bedford, to be slung on the davits of his steam yacht, *Northumbria*, thus enabling the accumulators to be used either for the propulsion of the launch or to supply light to the ship. Wherever steamships are lit by electricity, the adoption of electric launches in this way will prove a great convenience. Among those now in course of construction, may be mentioned one for the Sultan of Turkey.

A protracted series of experiments has been carried out in connection with tramcar propulsion, and although the mechanical arrangements employed have not hitherto fully answered expectations, it has nevertheless been successfully proved that accumulators are admirably adapted for this work, and, as soon as certain minor difficulties in connection with the gearing are overcome, the electric propulsion of tramcars by accumulators will become an important industry. The accumulators and gearing of the tramcar now running at Berlin were manufactured at Millwall.

With regard to foreign work, it is encouraging to be able to state that an order is in hand for 100 tons of plates for one installation alone on the Continent, which is certainly the largest work in connection with electric lighting as yet undertaken in any country.

The directors have much pleasure in stating that the litigation in the United States, in connection with the title to some of the patents owned by the Electrical Accumulator Company of New York, is at an end, and that that company has not only ample working capital, but has been strengthened by association with some of the most prominent commercial men in the United States, while the administrative control will be in the hands of those who have already achieved a remarkable success as managers of one of the leading enterprises in that country; the directors, therefore, regard the interest in the American company, of which hitherto no valuation has been made in the balance-sheet, as a valuable asset.

The manufacture and sale of secondary batteries has been carried on at Hamburg under a license from the company for North West Germany.

A claim has been made against one of the German Faure patents belonging to this company. The case is being tried in Berlin, but the directors have confidence as to the result.

The directors have pleasure in stating that the Imperial Continental Gas Association are now the licensees of the company in Austria and Hungary.

A suit in connection with the French patents is expected shortly to come on for hearing at the Court of Appeal, in Paris, but our French counsel advise that the position both as to law and as to fact is most favourable to this company. In the meantime, arrangements for the sale of accumulators on a more extended scale are being made.

As was stated at the meeting held in July last, the shareholders of the Indian and Oriental Electrical Storage and Works Company unanimously decided that their patents and patent rights should be transferred to this company, in exchange for £15,000 fully paid up shares. The details relating to this matter are now being carried out, and it is hoped will soon be completed. The directors anticipate satisfactory business to result now that the Indian rights are under their control.

A suit was brought against Elwell-Parker, Limited, in Vice-Chancellor Bacon's Court, for the infringement of one of the Sellon patents belonging to this company. The Elwell-Parker Company, however, eventually consented, without going to trial, that judgment should be signed against them, and a satisfactory arrangement has been effected under which they have taken a license on payment of royalty under this company's patents. A reciprocal arrangement exists by which this company has the benefit of any of the Elwell-Parker patents for secondary batteries, should it ever wish to use them.

In July last the directors, with the sanction of the shareholders, took power under the articles of association to issue £25,000 7 per cent. debentures, secured by mortgage of the plant and patents in the United Kingdom. The shareholders did not subscribe to the amount of their quota, but the directors, having full confidence in the business and prospects of the company, undertook to lend £10,000 at 4 per cent., or 1 per cent. above Bank rate if higher, as and when required, the company entering into an arrangement to secure the directors by a deposit of debentures to the amount of the advance.

The directors desire to express their great regret at the loss of their colleague, Mr. William Ladd, who died last autumn.

Mr. Sellon seconded the motion, which was carried.

A fuller account of this meeting will appear next week.

Brighton Electric Light Company, Limited.

The first general meeting of this company was held at Brighton last week. The chair was taken by Mr. Robert Hammond, who explained that this being only the statutory meeting required by the Act of Parliament, there was no report or accounts to present, but he had pleasure in stating that the agreements with the vendor had all been satisfactorily completed, and the business as a going concern taken over. Although the company was only registered on December 16th last, the business was taken over as from October 1st, and the accounts for the three months ending December 31st last showed a satisfactory profit. The directors did not, however, propose to distribute a dividend till the completion of the current year. He was glad to be able to add that the company's electric light undertaking might be considered a

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decided success, especially since it had been made a separate Brighton company. The light was gaining in popularity, and only that afternoon one of the leading doctors of the town had given orders for an installation in his private house, and he (the chairman) felt that a great extension of the company's business would take place as soon as it became known in Brighton that private houses could be supplied with the incandescent light at a meter rental, and paid for exactly according to the quantity consumed.

Eastern Telegraph Company, Limited.—This company announces the payment on April 14th next of a dividend of 3s. per share on the preference shares of the company, less income tax, for the quarter ending March 31st, 1886, and that an interim dividend of 2s. 6d. per share on the ordinary shares of the company, free of income tax, in respect of profits for the quarter ended December 31st, 1885, will be paid on the same day.

The River Plate Telephone and Electric Light Company, Limited.—This company notifies that coupons due April 1st next will be paid, less income tax, on and after that date, at the Alliance Bank, Limited, Bartholomew Lane, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 19th were £2,549, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited;

he Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 19th amounted to £3,134.

PROCEEDINGS OF SOCIETIES.

Physical Society, March 13th.

Prof. BALFOUR STEWART, President, in the Chair.

Prof. U. S. Pickering and A. C. Hayward were elected members o the society.

The following communications were read:—

"On the Growth of Filiform Silver," by Dr. J. H. GLADSTONE. It has long been known that if a piece of metallic copper be placed in a solution of nitrate of silver, replacement of one metal by the other will take place, the silver being deposited in the crystalline form, sometimes having a resemblance to fern leaves, or as superposed hexagonal plates or knobs. It was observed, however, as far back as 1872, by the late Mr. Tribe and the author, that if nitrate of silver were decomposed by suboxide of copper instead of the metal the silver presented itself in threads, which rarely, if ever, bifurcate, but frequently turn at sharp angles, or twist in every direction. This was described in the British Association report for 1872, and it was observed that the same forms occurred in native silver.

More recent observations have shown that the particular character and rapidity of formation of these threads depends very much upon the strength of the solution and the condition of the suboxide. Hydrated suboxide will scarcely decompose a two per cent. solution, even after standing. The threads, which bend at a sharp angle, usually do so at 60° or 120°; other threads, however, are symmetrically curved; but, especially in strong solutions, they are given to twisting about in every direction, and generally terminate in irregular knobs of silver. As a rule a thread continues to grow of the same thickness as it commenced, but it sometimes enlarges for a while into a flat plane, or becomes encrusted for some distance with small crystals of silver. When the solution is very nearly exhausted of silver, fine arborescent forms appear, but with the suboxide there are never produced the fern-leaved forms, or hexagonal plates, or the other distinctly crystalline structures which characterise the growth from metallic copper.

During the reaction the suboxide is changed into black protoxide and metallic copper, which dissolves; and the change will take place as well with the acetate and sulphate as the nitrate. If a mixture of suboxide and metallic copper be employed, not only do the distinctly crystalline and the filiform forms make their appearance, but strange intermediate forms come into existence.

"Apparatus for Measuring the Electrical Resistance of Liquids," by Prof. REINOLD. The apparatus consists of two bottles connected by a horizontal tube. The whole is filled with the liquid to be examined and immersed in water, by which means, and by thermometers inserted in each bottle, the temperature may be regulated and accurately ascertained. The electrodes are platinum plates, one dipping into each bottle. Two fine tubes terminate near the ends of the connecting tube, and electrodes are fitted into them at some distance from the ends; by connecting these to a quadrant electrometer or a condenser and galvanometer, the difference of potential between the ends of the tube can be compared with that at the ends of a known resistance in the same circuit.

"On Chromatic Photometry," by Capt. ABNEY and Lieut.-Col. R. FESTING. (This paper had been previously communicated to the Royal Society.) A series of experiments have been made by the authors to determine the comparative luminous effect of different parts of the spectrum. A monochromatic light from any part of the spectrum of the electric arc was obtained by a method devised by Capt. Abney, and previously described by him to the society [Physical Society, June 27th, 1885.]

The photometric effect at different parts of the spectrum was compared with that due to a candle at different distances by Rumford's photometer. In using this it was found best to place the candle in a given position, and obtain a balance by moving the slide upon which the spectrum was formed, and through a slit in which part of the light was allowed to pass, rapidly to and fro. For each position of the candle there are thus two corresponding positions of the slit. From the results of these observations a curve may be drawn showing the luminosity at different points.

From the method by which it is obtained it is evident that the curve of one observer is not directly comparable with that of another, since a deficiency of perception in any part of the spectrum would affect the light of the candle as well as that examined. Since, however, the curves obtained by a great number of persons coincide very closely with those obtained by the authors, they have felt justified in adopting them as the normal curves. In the case of the electric arc the normal curve attains a maximum rather nearer the red end of the spectrum than the blue. Assuming the normal curve, any other curve may be compared with it by increasing or decreasing its ordinates so that no part of it shall lie without the normal curve; in curves thus obtained, several of which were shown, deficiency in colour perception is often very clearly marked.

By the use of two or more slits in the movable slide, experiments were made upon mixtures of colours, and it was found in all cases that the luminous effect of a mixture of colours was the sum of the luminous effects of its components. It was also found that the colour of the comparison and the quantity of light admitted to form the spectrum were without effect upon the form of the curve. Light from the sun and from an incandescent lamp were similarly examined, though it should be observed that the result for sun light differs notably from that given by Maxwell. An examination has also been made of light after passing through a turbid medium and an expression of Lord Rayleigh's

$$\text{I}^1 = \text{I}\, e^{-x\lambda^{-4}}$$

where I is the original radiation, I^1 that after passing through the medium, λ the wave length of the light and x a constant depending upon the medium, has been closely verified.

Royal Society, December 10th, 1885.

"On the Magnetisation of Steel, Cast Iron, and Soft Iron," by JOHN W. GEMMELL.

In this paper the author describes and gives the results of a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of "soft Scotch iron," "common wire," "charcoal iron," and "soft steel," with bars of cast iron and malleable iron; and the object of the investigation was to find the difference between these with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force.

The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniell's, so arranged that any number of cells could readily be placed in the circuit.

The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure.

It has been found that the "charcoal iron" has the highest magnetisability, and the "soft steel" the lowest; while that of the "soft Scotch iron" approaches the former. With regard to retentiveness, the "charcoal iron" shows the least, and the "soft steel" the greatest. Annealing the latter, however, has the effect of bringing it very near the "common wire," both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus.

These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly.

In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop.

In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

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Birmingham Philosophical Society, February 11th.

"On Resistance at Surfaces of Electrodes in Electrolytic Cells," by G. Gore, LL.D., F.R.S. This paper is a purely experimental one, and contains new proofs of some of the chief results of an extensive research on "transfer resistance," communicated to the Royal Society, March 2nd, 1885) (*Proc.* Roy. Soc., 1885, No. 236, p. 209). In it the author shows conclusively that the phenomena discovered by him, and to which he applied that term, are not due to polarisation, some kind of electromotive force, or any other form of opposing difference of electric potential, because they still remain when those causes are entirely absent. He selected various cases of voltaic inversion, in which a pair of different metals in an exciting electrolyte produced no difference of electric potential and no voltaic current, and examined them for "resistance" and differences of "resistance" at the immersed surfaces of the two metals. He first tested them by a "bridge" method, and then by a "condenser" one, also described, and gives the results; and in every case he found that the "resistance" still existed, and was different in amount at the two plates. In each case the plates were of equal sizes. He also took several cases in which a pair of plates of the same metal, but of different sizes, were immersed in an exciting electrolyte, a combination which it is well known produces no difference of electric potential and no voltaic current, and tested them similarly, and found abundant evidence of "resistance," different in amount at the two plates in each instance. By the condenser method he also measured the amounts of such "resistance" at the surfaces of the two different metals, of several voltaic elements at their inversion points, during absence of difference of electric potential, and gives the quantities. He asks:—"Is the phenomenon I have discovered really of the nature of ordinary electric conduction resistance? If it is, its characters will agree with the most essential ones of that influence. It agrees in several important points with that resistance: first, it is not able to produce a current; second, it is usually small with those liquids in which ordinary resistance is small; and third, it is considerably reduced in liquids by rise of temperature, it also, when overcome by current, evolves heat" (*Proc.* Roy. Soc., 1885, No. 236, p. 209; *Phil. Mag.*, vol xxi., 1886, pp. 130—148). It differs, however, from such resistance in the less important circumstance that it varies in amount with the strength and density of the current; it is also usually much larger in amount than the ordinary conduction resistance of a short section of the same liquid. "From these various fundamental truths respecting it, 'transfer resistance' is a retarding influence essentially similar to ordinary conduction resistance, but modified, increased in amount, and rendered more complex by taking place at the surfaces of mutual contact of two heterogeneous bodies instead of in the mass of a homogeneous substance." He concludes by remarking that "it performs an important part in the action of all voltaic batteries and electrolytic cells," and calls attention to the circumstance that "one important practical application" of it "has been made in the electro-metallurgical purification of copper on the large scale, where a great saving has been effected by arranging the depositing vats in multiple series, and thus diminish the 'transfer resistance.'" It was in the year 1831 that the first attempt to discover this kind of resistance was made by Fechner.

Berlin Physical Society, December 18th, 1885.

Dr. Schulze-Berge spoke on the conduction of electricity in dielectric media, a subject which had hitherto been examined in most cases only from a technical standpoint, in order to determine the insulating power of gutta percha sheathings for telegraph wires and cables. If it were assumed that the resistance of the dielectrics differed with the thickness of the layer according to the same law as prevailed in metals, then—seeing that the resistance of a cubic centimetre of gutta percha was, in accordance with Jenkin's determination, equal to 25×10^{12} ohms—the thickness of a layer, the resistance of which amounted to about 100 ohms, and ought to be measurable, must be so small as to be incapable of being produced. It might possibly be the case, however, that in dielectrics the resistance varied in another relation to the thickness, and in point of fact the speaker had found that a gutta percha layer of 1/13 mm. thickness, and a superficies of 175 square c.m. inserted between two metal plates into the circuit of a Daniell's element connected to earth, produced a very rapid discharge. Measurements executed by the speaker by means of a quadrant electrometer on thin layers of gutta percha, sulphur, paraffin, and sealing wax between two metal plates, yielded resistances very well capable of being measured, and which in the case of gutta percha amounted on an average to about 200 ohms. In the case of sulphur the values varied between 20 and 2,000 ohms, and just as varied and irregular were the resistances in the case of the two other substances. The layer offering resistance was produced by placing rubber tissue or purest flowers of sulphur on a heated plate of zinc, and thereupon pressing the second heated metal plate, after which the whole was allowed to cool. In the course of time the resistance changed. In the case of sulphur it increased, in the case of paraffin and sealing wax, however, the resistance abated; in the case of gutta percha the resistance continued pretty equal. If the cells supplying the current were disconnected, and the dielectric brought into conjunction alone with the electrometer, then the latter showed no deviation, whence it was inferred that the dielectric did not conduct electrolytically, and that it was no electrolytic polarisation which caused the change of resistance. The measurements of resistance were also taken with the aid of the Wheatstone bridge, and, after the former results had been confirmed by this method likewise, the influence of the electromotive force on the resistance of the dielectrics was determined. If the bridge system was in equilibrium, then must it remain unaltered when the intensity of the current was varied by the insertion of a changeable resistance into the circuit of the current. The experiment, however, showed that with the change in the strength of the current the needle of the galvanometer indicated a deflection. This change of resistance with the change in the strength of the current was, as the speaker had become convinced, by means also of the bridge combination, through disconnecting the chain, not caused by an electrolytic polarisation, but probably by a dielectric polarisation, which would have to be further investigated after other dielectrics, besides the four mentioned, had been tested. The most important results of his experiments were formulated by the speaker as follows:—(1) The resistance of the dielectrics varied in relation to the thickness of the layer in a different way from metals. (2) The conduction of the dielectrics was not electrolytical. (3) The resistance depended on the electromotive force.

In the discussion following this address, Dr. Schulze-Berge further stated that the sensitiveness of his electrometer was so great that a Daniell gave a deflection of 120°.

Prof. Schwalbe gave a full report of the two volumes on "Geophysik," by Herr S. Günther, published last and this year.

NEW PATENTS—1886.

3756. "Regulating apparatus for arc electric lamps." J. D. F. Andrews. Dated March 17.

3849. "Field magnets for four pole dynamo-electric machines." P. B. Elwell. Dated March 18.

3883. "Electrostatic induction machines for lighting gas, applicable also for other electrical purposes." W. Grierson. Dated March 18.

3893. "Producing electric light." H. de Clairmont, C. L. Field. Dated March 19.

3925. "Adjusting and regulating the brushes employed in dynamo-electric machines." R. Sugden, A. D. Shaw. Dated March 20.

3945. "Electrical switches." R. M. Baily, A. Grundy. Dated March 20.

3946. "Method of and apparatus for transforming the conditions of electric currents." L. Bollmann, E. Biedermann, D. Monnier. Dated March 20.

3947. "Arc lamp." E. A. Ashcroft. Dated March 20.

3969. "Switch and resistance regulator for dental electric motors." A. M. Clark. (Communicated by Schafer and Montanus.) Dated March 20.

4038. "Mechanism for striking the arc and controlling the feed of carbons in electric arc lamps." C. Brown. Dated March 23.

4057. "Voltaic piles and accumulators." P. Haddan. (Communicated by I. Crosse.) Dated March 23.

4058. "Telegraphic recording instruments." A. M. Clark. (Communicated by New Haven Clock Company.) Dated March 23. (*Complete.*)

4069. "Telephonic apparatus." J. E. Daun, J. Lapp. Dated March 23. (*Complete.*)

4072. "Telegraph recording instruments." A. M. Clark. (Communicated by New Haven Clock Company.) Dated March 23. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

1854. "An improved electric arc lamp." T. Nordenfelt. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. The object of this invention is an automatically regulating electric arc lamp having two pairs of carbons intended to burn one after another. The top carbons with their holders, are exactly counterbalanced by weights and chains, in order to reduce to a minimum the power required for regulating the arc and maintain the length of the arc constant, whereby irregularities in the light are prevented as far as possible. The lamp is also arranged as a differential lamp.

1856. "An improved semi-incandescent lamp." T. Nordenfelt. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. The object of this invention is the production of a semi-incandescent lamp, in which the carbon is surrounded by a confined quantity of air enclosed partly by the tube of the lamp and partly by a glass globe, whereby the carbon forming part of a closed circuit is caused to glow in the midst of an inert gas, chiefly azolic gas and carbonic acid, owing to which the carbon will be consumed very slowly and the light rendered uniform because the carbon will not be exposed to draught, and because the combustion takes place in a confined, and, as far as possible, constant gas mixture.

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2271. "Improvements in electric current meters." J. W. Swan. Dated February 19. 8d. The apparatus consists of a clock, a galvanometer, and a train of registering wheels; these three parts are so connected together that if a current is passing in the circuit with which the meter is coupled, a periodic locking together takes place of the index wheel of the galvanometer, one of the clock wheels, and one of the train of registering wheels. This interlocking is maintained during a length of time, varying directly with the strength of the current passing at the instant the locking action took place, and is terminated when the index wheel of the galvanometer, which is carried round by the clock train, arrives at its zero position. Whereupon an electrical contact is made which closes an auxiliary circuit and causes an electro-magnet to effect the unlocking, and the movement of the registering wheels, therefore, ceases until the next period of locking occurs.

2776. "Improvements in dynamo-electric machines, magneto-electric machines, and electric motors." W. H. Allen, R. Wright, and G. Kapp. Dated March 2. 11d. The inventors employ an armature wound on the Gramme or Pacinotti principle and constructed as follows:—The core of the armature consists of soft iron wire or soft wrought iron discs, wound or slipped on to a supporting cylinder of brass, gun metal, cast iron or other suitable metal. This supporting cylinder is open at the ends, and its surface is provided with a number of perforations or slots, giving it the appearance of a grating bent into the shape of a cylinder.

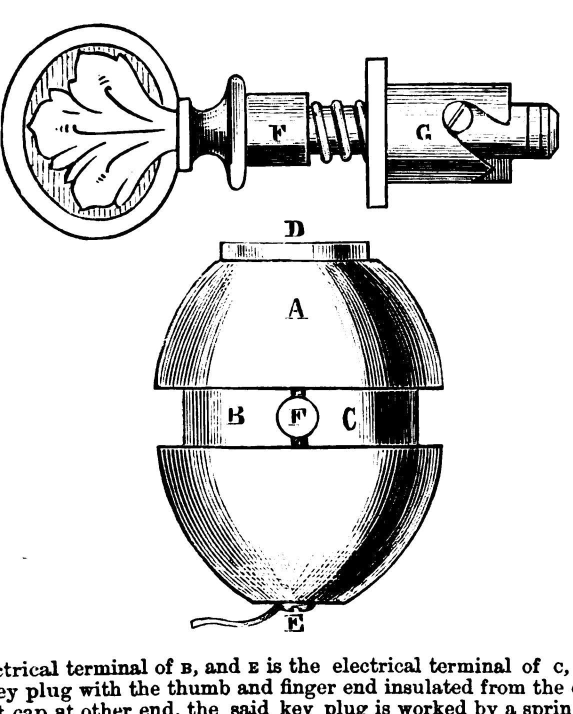
3553. "Electric relays." J. Enright. Dated March 19. 6d. The inventor brings the terminals of the circuit it is required to establish into mercury cups, and then arranges that a piece of wire shall have its ends plunged into the mercury, so as to bridge over the gap in the circuit.

3671. "Improvements in electric cartridges and electric primers therefor." S. Russell. Dated March 21. 8d. Relates to cartridges to be discharged by electricity, by the heating to incandescence of a conductor of high resistance in contact with the powder.

4155. "Improvements in boxes or cells for primary and secondary voltaic batteries." C. Moseley. Dated April 2. 4d. The inventor constructs the cells or boxes of wood to any desired pattern or form, and within each box or cell he secures a lining of India rubber or India rubber compound vulcanised or unvulcanised.

5256. "Improvements in voltaic batteries." A. R. Bennett. Dated April 28. 4d. With the object of increasing the constancy of the current produced by the various forms of voltaic batteries described and claimed in patents No. 302, 21st January, 1882, and No. 1901, 21st April, 1882, the inventor employs, in conjunction with the chemicals therein set forth metallic sulphides, more particularly the various sulphides of iron and copper and the joint sulphides of iron and copper. The sulphides or mixtures of sulphides and sulphur are used with the negative portion of the battery. They are mixed with the iron or other metallic borings or filings, or are made to cover or surround the negative plate of iron or other metal which need not in such a case be packed with borings, filings or other pieces of metal.

13902. "An electrical switch." G. Marris. Dated November 14. 6d. A, is a bulb of wood or any other suitable material, grooved and bored to receive the necessary metallic parts, B and C are metallic springs fitting into the grooves of bulb A, D is the



electrical terminal of B, and E is the electrical terminal of C, F is a key plug with the thumb and finger end insulated from the contact cap at other end, the said key plug is worked by a spring in barrel G, the said barrel having a diagonal movement slot with stop shoulder; on turning the key, F, the connecting cap on F is brought into pressing contact with B and C, thus closing the electrical circuit, the reverse action of F opening said circuit, the whole enclosed in an ornamental or plain case and forming a new switch.

15078. "Improvements in apparatus for forming conduit sections for underground conductors and the like." W. P. Thompson. (Communicated from abroad by J. R. Burdick and D. H. Dorsett, of America.) Dated December 8. 8d. Relates to improvements in apparatus or machines for forming conduit sections more particularly adapted for underground wire service, and of that class in which the sections are composed of some suitable insulating compound or material which is moulded to form through each section from end to end thereof a desirable number of straight bores serving as ducts or passages for the conductors, the sections being usually made cylindric with their ends adapted for coupling in order that, when laid underground or elsewhere, they can be connected together so as to provide a conduit having throughout a series of separate and distinct wire-receiving passages. The material which has been found best adapted for forming these conduit sections has been filled into the mould while in a heated, plastic condition, the cores for forming the ducts being introduced into the mould preparatory to the filling in of the plastic material or composition to be moulded.

15539. "Improvements in telephone transmitters." C. E. Allen. Dated December 18. 8d. Relates to improvements on the apparatus described in patent No. 6689, dated June 2nd, 1885.

CORRESPONDENCE.

Franklin Institute Tests on Incandescent Lamps.

With reference to Mr. Tatham's letter in reply to ours on the above tests, we are sorry that we did not see Mr. Wahl's letter in the New York *Electrical Review* of June 20th, which, however, we consider a somewhat weak denial, in face of the strong assertions made by the *Electrical Review*.

Mr. Tatham states in his letter:—"In the conduct of the tests the cardinal principle was to do right, and also to *avoid all appearance* (the italics are our own) of wrong doing. To this end a code was adopted and judges selected with the full concurrence of the contestants, and nothing was concealed from the parties in interest. The contestants were invited to inspect, and did inspect, every step in the progress of the tests, and their experts compared the photometric measuring powers of the judges with their own."

We are surprised at the Franklin Institute again making the above assertions. We beg most emphatically to deny that a code was adopted or judges selected with our concurrence. We deny that we were ever informed of what was in progress, and we were never invited to inspect, nor did we inspect any steps in the progress of the tests, nor had we experts to compare their photometric powers with that of the judges; but, on the contrary, never heard a word of our lamps being tested until we saw in the London Electrical Review that the tests were practically over. Mr. Tatham is incorrect when he says the "boast of our lamps is that they are brilliant and cheap." To advocate them on account of their brilliancy would be manifestly absurd; and, so far as cheapness goes, although our lamps are the same price to the general public as those of other makers, the trade are willing to pay, and do pay, a higher price for them than any other lamps. What we claim is that the efficiency of our lamps will be found considerably greater than that of other makers, while the life of our lamps compares very favourably with them.

With regard to the method adopted by the committee of running our lamps 5 volts higher than they were marked, we think that some statement should have been made of the fact that for some considerable time the lamps were run at from 25 to 32 C.P., or an efficiency of about $2\frac{1}{4}$ watts per candle-power (mean horizontal intensity), and yet in their report the committee use the words "possibly received more than their proper E.M.F." In the face of the above, these words present a needlessly incorrect view of the case.

With regard to Mr. Preece's statements, he had ample opportunity of testing the lamps at the Wimbledon trials, where they were run for some considerable

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time, our lamps being we believe the only ones of which none broke the whole time. As for the statement that some of the lamps were sent over by Mr. Preece specially to be tested by the Franklin Institute, the following is Mr. Preece's reply to our letters :—

"Gentlemen,—The lamps tested at Philadelphia appear to have been some of yours sent by me to a personal friend, who omitted to give me the faintest idea of the purpose for which they were intended. Had he done so I should of course have told you. I had the pleasure of inspecting an installation recently where your 20-candle lamps have obtained an average life of 1,500 hours, and many of them are now 'alive and kicking' after 4,000 hours work. They were 80 volt lamps running at 79 and taking ·73 ampères or 56·7 watts each. "Yours faithfully,
"(Signed) W. H. PREECE."

As we have every confidence in our lamps, we are only too anxious to have them tested in competition with those of other makers, and we shall be happy to subscribe £50 towards any tests such as mentioned lately by Mr. Crompton.

Woodhouse & Rawson.

Secondary Batteries as Regulators.

I hesitate to address you again this week, but your editorial remarks call for explanation. It is perfectly true that for a continued fall of speed, in the case of a dynamo, the E.M.F. falls, but if, with a shunt, the "falls" are sudden and spasmodic (say driven by a gas engine and tight belt) I found sudden rises of E.M.F. corresponding to the falls in the speed, as if the shunt coils acted somewhat as an induction coil. It may have been a special case, but it appears not unlikely to be the rule if the curve of the machine drops rapidly.

I notice a printer's error in line 4 from the bottom of my last week's letter, which alters the meaning completely. Read "corrected" for "connected."

I fear you are rather misled as to my meaning of "a good dynamo electrically." By this is understood a machine (shunt) giving a curve which shall be almost a straight line; in other words, the armature shall have a resistance approaching zero as near as possible, and, of course, otherwise well designed, for the falling curve indicates appreciable resistance in the armature, showing avoidable waste.

You say makers of dynamos consider that a machine with a very drooping curve is most suitable for charging cells. I believe that I was the first to point this out in the paper I wrote on "Constant Electromotive Force, &c.," and it is perfectly true that good regulation may thus be attained, and the paper showed at the same time that other dynamos failed in this respect. In the discussion which ensued Mr. Crompton and others condemned such dynamos as wasteful, and declared them machines of the past. In replying I agreed, except for small installations, which were then under consideration. In short, to work cells properly to secure good regulation, a dynamo with a curve of much fall should be used; in other words, a machine with an armature having considerable resistance, and therefore wasteful. On the other hand, if a good machine were employed, with a nearly straight line for its curve, so that the E.M.F. is practically constant for all currents given off to the limit of its power, it will give no regulation whatever, except by the law of shunt currents. In large installations these latter dynamos only can be used.

One word on the question of the *s.g.* of the acid in a cell and its E.M.F. as indicating the state of charge. The voltmeter is unquestionably the best test, but it is variable because the cells will not always give the same E.M.F. when they have been long in use. Again, when the cells approach the end of the charge, the E.M.F. rises but very slightly and it is not easy to detect the variation. The hydrometer has many faults; but two virtues it possesses, one is that it rises during the charge, and, secondly, a time arrives when it rises no more, or, at any rate, one or two hours' charging does not appreciably affect it. Thus the "fully charged" problem may be solved, especially if two Ferranti meters are employed, by comparing three things:— 1. Charge till the E.M.F. indicates no more rise. 2. Observe if the hydrometer also ceases to rise appreciably. 3. See if the meters indicate that the ampère hours put in exceed somewhat those taken out.

The "boiling" test might be added, but this does not always take place when it should do; much overcharging is often required to produce this result.

David Salomons.

Broomhill, Tunbridge Wells.

A Testimony to Secondary Batteries.

Prof. Sir William Thomson, F.R.S., writing from the University, Glasgow, has kindly forwarded for publication the following copy of a letter addressed by him to Mr. Bernard Drake, the Engineer to the Electrical Power Storage Company :—

(COPY.)

Dear Mr. Drake,—Your storage cells have given me the greatest satisfaction. I have used 44 of them for my house lighting ever since I got them first charged up, within a few days after receiving them from you (November, 1885), and they have worked to perfection. It is the greatest possible comfort to us in the house to have the light with satisfactorily equal brilliancy at all hours of night or day and every day of the week. I have now cut off the gas at the meter, so that there is absolutely none used in the house. I have no oil lamps, and have not used so much as a single quarter of a candle within the last three months, and I have the electric light in every part of the house where light can possibly be wanted by night or by day. I find by a little management, of throwing off a few cells from the house circuit when the engine is going, and throwing them on when it is stopped, that there is no difficulty in keeping the potential at the house within 2 or 3 per cent. of absolute constancy. I use a Clerk gas engine to drive the dynamo, and find that it is impossible to tell by the appearance of the lights whether the engine is going or not. Before I had your secondary battery we could always see a pulsation of the lights in time with the revolutions of the engine. The absolute steadiness of the light which we now have is most satisfactory and pleasing.

I have six of your cells continually in use on my laboratory table, and they are charged according to need by joining them in parallel and putting them into the charging circuit; so that when they are being charged the engine is called upon to work against a potential of 45 cells instead of, as usual, a potential of 44 cells. This makes scarcely a sensible difference to the engine; it merely lets it go a little faster, and causes it to give a slightly smaller current. Of course, a sixth part of this charging current passes through each of the laboratory cells. I use these cells for laboratory purposes, sometimes keeping them joined in parallel and sometimes joining them in series according to my laboratory needs. It is a great convenience to me to be able to get at any moment 180 ampères for testing and adjusting my electrical measuring instruments. With this varied and irregular use in my laboratory the six cells keep in perfectly good order. I suppose if I take care never to run them down too low, they will keep in good order for years.—Yours truly,

(Signed) **William Thomson.**

Electric v. Oil Lamps.

On page 256 of last week's issue under the head of "Lighthouse Illuminants" you say: "There is much contained therein (the *Society of Arts Journal*) of interest to the electrical engineer, the remarks of Mr

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R. E. Crompton being very much to the point, for he shows that the electric light can as well be used for a small light as a big one, and that then, instead of being two-and-a-half times dearer than oil, its cost might be reduced to *one-and-half* times less." This certainly is interesting were it not, as I imagine, a misprint; since I for one was not aware that the electric light companies were in so flourishing a condition as to enable them to pay their consumers half the amount of their former oil bill in addition to the advantages of electricity as an illuminant.

Arthur E. Cotterell.

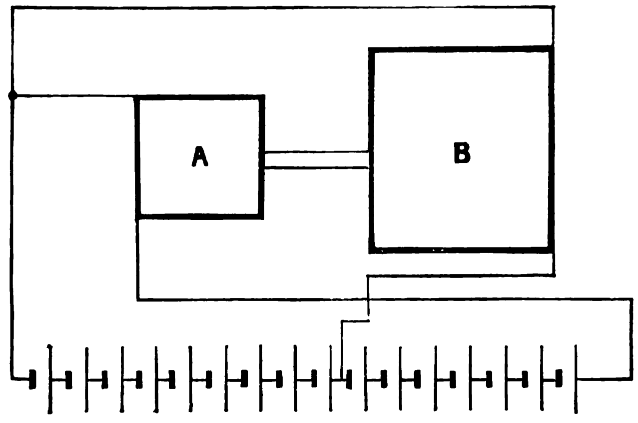
Birmingham, *March 23rd*, 1886.

[Our correspondent apparently mistakes Mr. Crompton's meaning. Surely an arc light can be very economically produced! The subject under discussion was not one dealing with electric light supply companies and consumers generally, but with single arc lamps for special purposes.—EDS. ELEC. REV.]

"Dynamo Tests."

With reference to Lord Rayleigh's suggestion in connection with this subject, I may mention I have for some months employed a method somewhat similar for testing motors, although I have not yet used it for obtaining their efficiency.

A is the motor which is worked by secondary batteries; this is coupled direct to the dynamo, B, the current from which charges some of the cells.



At present the method of experiment is:—1st. The motor is tested with a Prony brake, and the H.P. it gives out at a given speed obtained; it is then connected as shown, and the same speed obtained by varying the number of cells B has to charge. The method was originally devised for running motors for several hours, to test for heating, &c., without much expenditure of energy.

The dynamo is a large one, and had I known its efficiency at different speeds and currents, I should have measured the efficiency of the motor by means of it instead of using the brake. As it is, I hope before long to have a complete calibration of its efficiency, and I shall then do away with the brake.

With this method there is no necessity to have the machines the same.

Herbert W. Butler.

Laboratory, Electrical Power Storage Co.,
Limited, *March 18th*, 1886.

The Electric Meter as a Secondary Battery Indicator.

There is no doubt the method of using one meter in the charging and another in the discharging circuit (and which Sir Thomas S. Bazley mentioned in your last issue) is really the best means we at present have of ascertaining the charge in secondary batteries. I think, however, that a single meter, by varying the direction of its motion with the change in the direction of the current, might be made to show directly the number of ampère-hours in storage. During charging the finger of the meter would advance, receding again in correspondence with the discharge, thus doing mechanically the subtraction sum necessary with two meters. In meters in which the direction of the motion is not dependent on the direction of the current, a reversing clutch might be placed between the meter proper and its counting gear, a magnet or solenoid (permanently magnetic by a local current from the battery) being attached to the lever of the clutch, and acted on by a solenoid in the charging and discharging circuit.

In this way, also, a glance at the meter would at once show the attendant the state of the battery, or by means of contacts on the dial of the meter (the contacts being in connection with suitable relays), the dynamo circuit might be automatically opened, when the battery was charged, and closed again when any predetermined discharge had taken place.

I may add that the electric meter is attaining a simplicity and perfection that quite warrants its use in the above manner.

G. E. Dorman.

Stafford, *March 22nd*, 1886.

Theatre Lighting.

Noticing in your issue of 19th inst. the report of the second year's working of the installation at the Prince's Theatre, we think that you may probably be interested to receive a few particulars regarding our installation at the Theatre Royal in this city. This installation was made in December, 1882, from which time it has worked without the slightest hitch.

In January of last year we were requested to put incandescent lamps in the footlights, in order to do which it was necessary to remove the gas fittings—the confidence of the lessee had not been sufficiently strong to allow this at the outset. The lamps, which are of the Edison type, have been running about 6,000 hours; there are still many of the original ones in use, and none of the renewals have given out yet.

The dynamos are four Edison 250-light machines, which are worked at varying loads as scenic effects may require; during the whole time the commutators have not worn more than $\frac{1}{32}$ in., and the wear of brushes has only been $\frac{7}{8}$ in. each.

In November, 1884, we extended the installation in order to light the Comedy Theatre, which has been done with equal success; and a few months ago we added a large set of Elwell-Parker accumulators for the lighting of a warehouse and a concert hall in the vicinity by means of the same plant.

J. R. Williamson.

Manchester Edison Company,
March 23rd, 1886.

"Dynamo Testing."

In looking over the results, published in your issue of the 12th inst. (p. 230), of the recent tests of the Edison-Hopkinson machines at Manchester, I am somewhat puzzled as to how the method employed can lead, rigorously, to the required determinations of efficiency. My difficulty is entirely distinct from those practical difficulties referred to in the article regarding the measurement of the actual power transmitted by the belt to the shaft. It seems to me that the equations involved always contain at least one unknown quantity more than the method gives data for eliminating, and I should feel greatly obliged if you would kindly indicate how Dr. Hopkinson treats the observations so as to obtain the separate efficiencies of generator and motor.

R. Mullineux Walmsley.

Technical College, Finsbury,
London, E.C., *March 23rd*, 1886.

[Probably Dr. Edward Hopkinson will give Mr. Walmsley the desired information.—EDS. ELEC. REV.]

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Secondary Generators.

In the course of the last week Prof. Forbes, as well as some other gentlemen, have ventilated the advantages and disadvantages of connecting inductional transformers for alternating electric currents in multiple arc with the high tension mains.

We are glad to see that some of the writers on this subject agree in their views with those held by us for a considerable time, and also that the scientific side of the question is becoming the object of investigation by men of science. But as to the industrial side of the question we beg to state that the connection of alternating current transformers with their primary coils in multiple arc and supplying same with alternating currents of sensibly uniform tension is the subject of our English patent No. 3379, dated 16th March, 1885, and that the same is patented to us in Germany and in most industrial countries of the world. We are also determined to defend our rights relative to this invention with all the means provided by law.

Charles Zipernowsky.
Max Deri.
Otto Titus Blathy.

Budapest, *March* 18*th*, 1866.

Telephone Patents.—To "Combination."

Edison's claim to "the combination of a diaphragm or tympan with a tension regulator" has been sustained by the Courts in England, and I see no reason to question his right to that combination. What a *diaphragm* or *tympan* is, in a telephone transmitter, has not yet been judicially decided in England.

I shall send for the next REVIEW descriptions and drawings of telephone transmitters—without a diaphragm or tympan, or the shadow of one—which I shall offer free to the public generally.

W. C. Barney.

Washington, No. 917, Sixteenth Street,
March 10*th*, 1886.

American Telephone Patent Litigation.

I herewith send to the REVIEW what purports to be a complete synopsis of the Government Bill in the Bell telephone case. I cannot vouch for its accuracy, and I am inclined to question it, because there are so many allegations against the validity of the patent which I know are not sustained by the evidence before the Secretary of the Interior, all of which I have had an opportunity of reading, through the courtesy of Mr. Jenks, Assistant Secretary of the Interior.

In my comments on this bill I assume that it is the *true* Bill. It is therein stated that "Prof. Bell's application was filed later in the day" than Mr. Gray, who filed a caveat the same day, namely, 14th February, 1876. Now, the fact established by the written documents in the Patent Office was, that Bell's application was filed two hours before Gray filed his caveat. The bill alleges "that Bell claims to be the original and first discoverer of an invention which is called the undulatory current of electricity." This allegation is not true. Bell does not make such a claim; but, on the contrary, he says in his American and English patents such a current and a way of making it has long been known.

It is alleged in the bill that the Examiner, Z. F. Wilbur, communicated to Bell the "wording" of certain parts of Gray's caveat. No evidence of that fact was produced before the Secretary of the Interior, nor is there any evidence to be found in the records of the Patent Office; but there is written evidence that Wilbur did communicate to Gray parts of Bell's specification.

I believe that I have read and heard all the evidence that has been brought forward against the Bell patent of 7th March, 1876, and I am clearly of opinion that, if the bill be as the enclosed document says it is, the court before whom it may be tried will sustain Bell's claim to the use of an undulatory current in a speaking telephone; or, to be more precise, to the use of a *closed* circuit for telephonic purposes.

The bill proposes to question the validity of the Bell patent of 30th January, 1877, which is virtually the claim "to the iron plate held down around its edge in front of, close to, but not touching a pole of a magnet." The fifth claim of this patent is for a "magnet with a coil upon the end or ends of the magnet nearest the plate." This is a claim, *per se*, of such a magnet and coil. Now, unfortunately for Mr. Bell, such a magnet was used by Prof. Hughes in his printing telegraph; descriptions and drawings thereof were published in a work by my friend the late Count Du Moncel, entitled "Traité de Télegraph Electrique," published in 1864, also by Schellen, therefore that claim fails; but fatal to the validity of the whole patent is the fact well established that Bell had in his possession, and consulted a book in which that magnet is described and illustrated, and yet Bell has made oath to having invented that magnet; this invalidates the whole patent.

As to prior inventions of a speaking telephone, I think the court will require satisfactory evidence that prior to Bell's patent of 7th March, 1876, there was a speaking telephone described and published in some printed book. Now, it is well known that there is not any printed book describing a speaking telephone prior to that date, if we except the description of Bourseul's telephone published in a newspaper in Paris on 30th July, 1854.

It is not wise to make predictions, but I will venture to say that Bell will be able to hold under his patent the use of an *undulatory current* or of a closed circuit in a telephone.

W. C. Barney.

Washington, 917, Sixteenth Street,
March 10*th*, 1886.

Prof. Thompson's Valve Telephone.

I noted the remarks of your correspondent "Combination" in your issue of 5th March *re* the Valve Telephone, and also those of Mr. S. F. Walker in your last, and I am sorry to say that our firm had the same unfortunate experience with the New Telephone Company's instruments, as sent out in October of last year. In our case, also, a gentleman was sent down from London to fit them up, but failed to make them work satisfactorily, and after several trials they were sent back.

"Combination" in his letter mentions that an "expert" was sent to fix his firm's instruments; but if this was the same gentleman who waited upon us, he informed us at the time that he had only then been in the employment of the New Telephone Company for about a fortnight. Should I be right in my conjecture, I scarcely think "Combination" is justified in classifying him as an "expert."

The New Telephone Company lately forwarded us a set of their most recent pattern instruments, and on fitting them up over a short metallic circuit we found them to work in an exceedingly satisfactory manner; the articulation being clear and distinct, and not of the "Punch and Judy" type mentioned by "Combination." On the New Telephone Company's Inspector calling two days later, we disconnected them from this line and connected them to a circuit about $\frac{3}{4}$ mile long, and with equally satisfactory results.

Should "Combination" visit Glasgow and favour us with a call, we shall be glad to show him these instruments connected up between our premises here and an office about $\frac{1}{4}$ mile distant, the wire coming in close contact to that of the National Telephone Company.

A. W. Hine.
OF HENRY BENNETT & Co.

45, Bothwell Street, Glasgow,
March 16*th*, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 436.

ENGLISH TELEPHONE PATENTS.

A LITTLE more than seven months ago Mr. Justice North intimated that his judgment in the telephone case, which had been before him then for several days, would be for the plaintiffs, that is to say, for the United Telephone Company against Mr. Bassano, whose telephone transmitter was alleged to be an infringement of that of Edison. Last Saturday, he delivered judgment formally, occupying more than three-quarters of an hour in reading rapidly the lengthy document which he had prepared. The reasoning had need to be elaborate and to require time, to reconcile the judgment with the facts of the case: and after wading through the six columns of the judgment, reprinted in another part of the REVIEW, we venture to assert that the majority of our readers will be far from convinced that Mr. Justice North has reconciled them. A valued correspondent draws particular attention in our other columns to some of the striking passages, a free version of which he presents. For ourselves, we have so often given our views on the matter and opened our columns for its discussion, that nothing remains but for us to say that we remain unshaken in our belief that Edison did not intend to make such an all-embracing claim as that which is now maintained for his specification, and that it is a reduction of argument to the point of absurdity to seriously advance the extraordinary statements with reference to a diaphragm which have now been legally justified.

WHAT IS A GUARANTEE?

IN another column will be found the report of a case which occupied the attention of the judge in the Lord Mayor's Court at the Guildhall on Friday last week. This case, Crossley *v.* Littleton, presents one or two curious features, and intending purchasers of Otto gas engines will find it interesting. Messrs. Crossley Brothers claimed for repairs executed on a gas engine, those repairs having become necessary within a month of the sale. Mr. Littleton urged in defence that he held a guarantee from the plaintiffs that they would put right all derangements occurring through ordinary usage during the first six months after they supplied the engine. But Messrs. Crossley disclaimed having sold the engine to Mr. Littleton at all. The latter alleged that he purchased from the plaintiffs, but through a third party whom he distinctly understood to be their agent, and who was sent to him by their manager. Upon this point, as to whether the third party, a Mr. Heath, was or was not an agent of the plaintiffs, which was really the main question at issue between the parties, there was direct conflict of evidence. Mr. Littleton was positive that Mr. Heath was represented to him as an agent for Messrs. Crossley Brothers, and the plaintiffs' manager was equally sure that he merely recommended him as a middle-man, or "a man in the trade," who was willing to negotiate the business at a low rate of commission, the difficulty in the way of a direct deal being that the defendant insisted upon being supplied upon trade terms, to which the plaintiffs' manager did not consider him entitled. This "man in the trade," according to the latter theory, was to purchase the engine at the usual trade discount price—15 per cent. off—and sell it again to Mr. Littleton at an advance of 2½ per cent., a rate of profit which any considerable "contractor" might be expected to disdain. It was expected that the case would be fought out upon this question, and witnesses were examined and cross-examined mainly with reference to it. But after all evidence had been called, and the counsel for the defendant was addressing the jury on behalf of his client, the judge suddenly discovered that the first question which the jury would have to decide was whether the repairs were such as would, supposing no dispute to exist as to the direct sale from the plaintiffs to the defendant, be covered by the terms of the guarantee. Interrupting Mr. Corrie Grant, defendant's counsel, he reminded the jury that a witness early in the case had stated that the repairs carried out were not such as were usually done under the guarantee, that the witness was not cross-examined on the point, and that the fact was therefore not really disputed. Mr. Corrie Grant was labouring under the difficulty of having been instructed but a few hours before the commencement of the case, and could only mention this in explanation of his omission to cross-examine upon the question of the guarantee. The plaintiffs' counsel seized upon the new point in his favour and made the most of it; and in the summing up which followed, the judge once more insisted at length on the importance of the new phase which he had himself given the case. It was for the jury to consider first, he told them, whether the repairs were covered by the terms of the guarantee; defendant had called no evidence to prove that they were, and had failed to cross-examine the witness who said they were not, and therefore—the inference was plain. If they found that the repairs were outside the guarantee, they must without further ado give a verdict for the plaintiff; but if they found that the work was what might reasonably have been done under the guarantee, then it would be for them to consider whether the plaintiff or the defendant was to be believed with reference to the part which Mr. Heath took in the transaction. After this positive kind of summing up, the jury did not require many minutes consultation before they, without answering specifically the two questions put to them, returned a verdict for the plaintiff for the whole amount. It may be assumed that it was upon the question of the guarantee that they justified their verdict; and this brings us to the motive of our remarks. Do manufacturers attach

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any value to the guarantees which they give with their engines, or do they repudiate liability for all repairs after the engines have left their hands? In this case, the joints separating the cylinder from the water-jacket became imperfect after very little use, and allowed the water to percolate into the cylinder, with the result that the engine was soon brought to a standstill. Was not the repair needed here one which a guarantee might reasonably be held to cover? Intending customers of other manufacturing firms would do well, in face of the result of the case under notice, to have a clear and explicit understanding as to the real meaning and nature of the guarantee which are so readily given but so reluctantly acted upon.

DETERMINING THE COEFFICIENT OF SELF-INDUCTION.

Use of the Aperiodic Galvanometer, Deprez-d'Arsonval.—In a former communication, writes M. Ledeboer in *Comptes Rendus*, we have considered the case where there is in the external circuit of the Deprez-d'Arsonval galvanometer such a resistance that the movement may be aperiodic, but on the point of becoming periodic.

Under these conditions the aperiodic galvanometer may be substituted for the use of the periodic galvanometer; the only difference is the introduction, in the formula of the balistic galvanometer, of the factor e, the basis of the Napierian logarithms.

This may be done in particular for the determination of the coefficient of self-induction in Maxwell's method, as it has been applied by Lord Rayleigh.

The formula in question becomes under these conditions:

$$L = r \frac{T}{\pi} \frac{\delta}{a} c$$

The substitution of the aperiodic for the periodic galvanometer renders this matter very practical; for not only the former is unaffected by the presence of magnets, or even of powerful currents, but we avoid at the same time all the inconvenience due to the persistance of the movement of the galvanometer needle.

When the resistance of the coil whose coefficient of self-induction is being determined is weak, the above method has the inconvenience that the additional resistance, r, is very small. For certain coils which we have made use of the resistance was 0·2 ohm, and the additional resistance, r, was 0·0025 ohm to 0·0040 ohm. It is difficult to determine exactly the small resistances even if we use the double bridge method of Thomson.

In such cases it is more advantageous to apply the direct formula

$$L = \frac{T}{\pi} \frac{i}{a} e \frac{\delta}{I} \left[(R' + l' + g) \frac{R}{R'} + g \right]$$

in which $\frac{i}{a}$ is the constant of the galvanometer, the total resistance of which is g; R, R′ l, l' the resistances of the four branches of the bridge; R that of the coil, the coefficient of self-induction of which is L, with $\frac{R}{R'} = \frac{l}{p}$, the galvanometer being interposed between R and R′ on the one part, and between l and l' on the other.

We append here some measurements taken by the aid of these methods. We have measured the coefficient of self-induction of the two electro-magnets of identical forms, the one being wrapped with thick wire and the other with a finer wire; the same system of soft iron cores may be introduced into either of these systems of bobbins.

Electro-magnet with thick wire (resistance = 0·234 ohm).

	L without iron.	L with iron.
r = 0·0025 ohm. Thomson galvanometer ...	0·00084 × 10⁹ *cm.*	0·0087 × 10⁹ *cm.*
r = 0·0040 ohm. aperiodic galvanometer ...	0·00085 „	0·0088 „
Direct method	0·00077 „	0·0086 „

Electro-magnet with fine wire (resistance = 6·76 ohms).

	L without iron.	L with iron.
r = 0·05 ohm. Thomson galvanometer	0·021 × 10⁹ *cm.*	0·22 × 10⁹ *cm.*
r = 0·50 ohm. aperiodic galvanometer	0·023 „	0·23 „
Direct method	0·023 „	0·23 „

WESTON'S CURRENT AND ENERGY METERS.

In 1824 Arago made his well-known experiment of causing a rapidly rotating disc of copper to induce a similar motion in a magnet placed above and parallel with it. He went so far even as to reverse the experiment, and effected the rotation of the disc by revolving the magnet. The explanation which he gave for this phenomenon was not satisfactory, and not until Faraday took up the subject was the true nature of the forces at work revealed. Faraday, however, went further than Arago, and recognising the fact that the motion produced was due to induced electric currents, proceeded in 1831 to produce a current generator, or magneto-electric machine, upon this principle. The apparatus took the form of a copper disc rotating between the poles of an electro-magnet, the current being taken off at the axis and at the circumference of the disc. Faraday at that time did not recognise the fact of the reversibility of the machine he had constructed; but in the light of our present knowledge it is evident that if a current be sent through the disc from an outer source, it will revolve, or in other words, become a motor.

It is upon the latter consideration, states the New York *Electrical World*, that Mr. Weston has constructed two very ingenious instruments, which, while analogous in principle, are used for different purposes of electrical measurement.

The principle upon which these instruments are based, viz., that of moving a conductor in a uniform field, is, in so far as its application to measuring instruments is concerned, original with Mr. Weston, who already in 1884 had constructed instruments on this principle, and from which the ones illustrated have been developed. Ferranti, in England, has constructed a meter in which this principle is employed, but, as stated above, Mr. Weston antedates him.

The first of these, the current meter, is shown in fig. 1 in perspective, fig. 2 being a section through the pole pieces. The instrument is essentially an electromotor having a disc armature, but the motion of which is prevented by opposing springs. The field magnets employed are similar to those in machines with consequent poles, and the pole pieces are extended toward each other and brought close to the disc, A, as shown in fig. 2. The disc, as will be seen, is centred upon a copper rod, E, which passes through cores in the pole pieces and is supported at its upper end by a double-spiral spring, S, attached to the bracket, F. The lower end of the rod, E, is enlarged so as to form an inverted cup, which carries within it a cork, K. It dips into a trough of mercury, which forms an electrical connection for the copper rod, the cork acting as a float to relieve the spring of considerable weight. The outer edge of the disc, A, is bent downward, and dips into a circular trough of mercury, b, formed in the lower pole piece. A small screw, b', acts as a binding post; the lower mercury trough, L, mounted upon the base, being

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also connected with a binding post, as shown in fig. 1. We must also add that the upper end of the screw carrying the springs is insulated from the bracket.

With this much by way of explanation, it becomes clear that a current led into the lower mercury trough

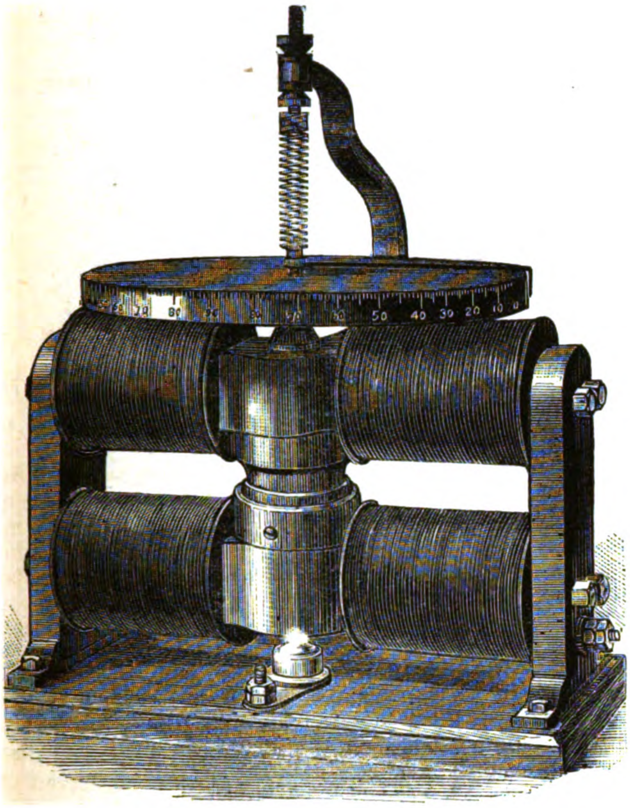

FIG. 1.—WESTON CURRENT METER.

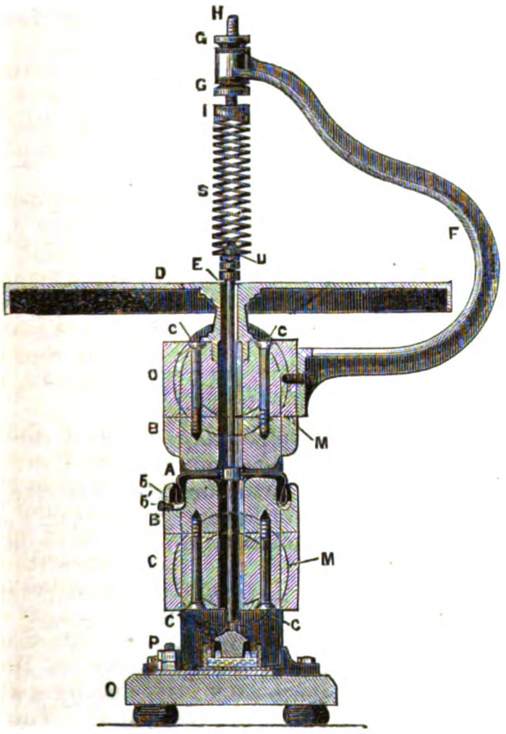

FIG. 2.—WESTON CURRENT METER—SECTION.

will pass up the rod, flow through the disc, and pass out through the upper mercury trough and binding screw. The disc being placed between powerful magnets, and having a current flowing through it, will naturally tend to revolve in accordance with the well-known law. Its motion is prevented, however, by the springs, which undergo a torsion proportional to the strength of the magnetic moment between the disc and armature. The stronger the current passing through the disc, the greater will be its tendency to revolve, and hence to distort the spring. The latter, as will be seen in fig. 1, has a pointer attached to it which passes over a graduated scale, and in this way the deflections of the spring are noted.

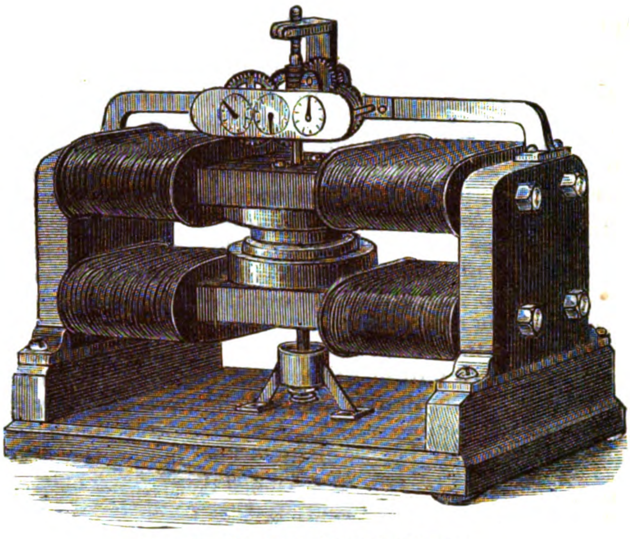

FIG. 3.—WESTON ENERGY METER.

While the instrument just described measures the current only, the one shown in fig. 3 measures continuously the energy passing through the circuit, or, in other words, the volt-ampères, and thus constitutes an electric meter. The principle upon which it is constructed is the same as that of the current meter, but instead of the motion of the disc being opposed by a spring, it is allowed free play and thus acts as a true motor. The spring, as will be seen, is replaced by a recording train upon which the number of revolutions are registered. The field magnets of high resistances are placed in independent circuit with the leads, and the strength of the magnets is thus proportional to the potential of the circuit. The full current, however, passes through the disc in the manner described above. Evidently the speed at which the disc revolves is proportional to the strength of the current in the disc and to the strength of the magnetic field. Thus the speed of the disc is a true measure of the energy in the circuit, indicating simultaneously the potential and current.

It is evident that the capacity of both instruments is practically unlimited, as the current which can be passed through them depends merely upon the size of the spindle and revolving disc. This is a great advantage, as it enables the instruments to be adapted for widely differing services and with equal accuracy.

Senegal Land Lines.—Recent news from this Colony shows the interruption of the landline which was lately completed, and which connects the French station of Bamakou, on the upper waters of the Niger, with the coast towns of Senegal. The section between Bakel and Matam is that which has suffered. Some time back we noted the energy and enterprise with which the construction of this line was being carried on by Monsieur Hubler, the chief of telegraphs for the colony of Senegal; who, without that military protection which has always been considered necessary (in the disturbed district between Bakel and Matam where the fighting is now going on), was successful in completing the last length, in a series of sections which unite the Upper Niger district with the coast, thus carrying telegraphic communication with Europe to a point which is over 700 miles inland, and which is only some 300 miles distant from Timbuctoo.

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ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XV.

MOTORS which are destined for the propulsion of road vehicles require a different treatment from those which are to be used for driving fans, for instance, or boats. Where great inertia has to be overcome, as in the case of a car or a crane, then it is necessary to provide motors capable of exerting a large initial force, or statical pull. The starting of a tramcar demands an effort of considerable magnitude, whereas the setting in motion of a fan or a screw-propeller requires comparatively little force, air and water offering little resistance until a certain speed is attained. For the starting of a tramcar we have to consider not the *rate* of expenditure of energy, but merely the statical force, or the magnetic attraction between the armature and the field magnets of a motor.

To set a 5-ton car in motion on a level tramline we must provide a pull of at least 500 lbs. in the direction parallel to the motion of the vehicle; for starting the same up an incline of, say, 1 in 37—three times that initial force will be requisite. The motor, therefore, has to be constructed to give a statical force of from 500 to 2,000 lbs., according to the conditions of the road, and the ordinary laws of electro-magnets have in this case to be taken into consideration; we know that the magnetic moment of a given field magnet is proportional to the current strength, or with a given current to the number of turns in the magnetising coils. The armature of a series-motor receives the same current as the magnet, therefore the statical force of such a motor will vary as the square of the current strength; with 80 ampères flowing through a series-motor there would be a starting force of 6,400 arbitrary units. The value of each unit depends upon the size and construction of a machine, and it merely serves for the purpose of comparison. Now, if we wish to obtain a considerable effort with a reasonably low current, we have to provide a large number of turns of wire in the coils, and this involves, in a given space, appreciable resistances; and we have seen that the resistance of a car-motor must be comparatively high in order that excessive currents may be avoided at the instant of starting. Therefore, high-resistance motors are an advantage under these circumstances. In dynamos (generators) we carefully avoid internal resistances, for reasons well known to electricians.

Many arguments have been brought forward with reference to the superiority of drum armatures over ring armatures; the inner layers of copper wire of a Gramme armature, it has often been observed, are practically useless for the production of currents in a dynamo machine; but these inner layers of wire appear to contribute their share in magnetising the armature iron core, and thus assist materially in the production of the desired magnetic moment so useful with motors.

The author's experiments have shown that with the same amount of iron, copper, and the same current flowing, the statical effect due to Gramme (ring) winding is superior to that of Siemens's (drum) winding, and, again, the statical effect of the Paccinotti ring is very much greater than that of the Gramme ring, with the same amount of material and the same expenditure of energy.

The model constructed for this purpose consisted of an ordinary horseshoe shaped electro-magnet, with polepieces to receive the armature; the iron core of the armature was cut from a tube $3\frac{1}{2}$ inches in diameter, $3\frac{1}{2}$ inches long, and $\frac{1}{4}$ inch thickness of metal; diametrically opposite, and parallel to the axis, were two projections of strips of iron rivetted to the iron tube, $\frac{3}{16}$ inch thick, and 1 inch wide, extending to the ends of the tube. Four wire coils were wound upon this core, equal in depth to the iron teeth or projections, and the ends of the coils were joined in series to a four-part commutator. This formed a ring armature with two Paccinotti teeth, held to a spindle by two gunmetal brackets; upon one end of this spindle a V-grooved pulley was fastened, and a cord surrounding part of the groove served for suspending weights. The commutator was fixed to the spindle so that by turning the armature through 90° the teeth of the iron core were either in the neutral magnetic position, or they formed poles opposite to the field magnet poles as shown in figs. 13 and 14. Currents

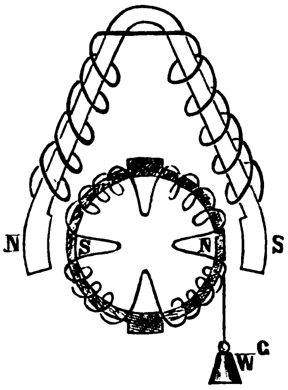

FIG. 13.

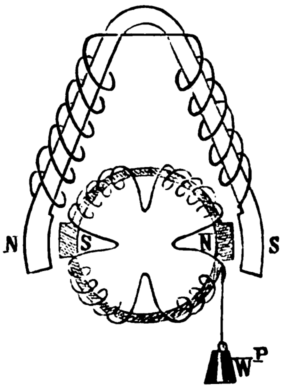

FIG. 14.

from a battery were sent through the magnet and armature, in series, and weights, W, suspended at the end of the cord, the weights were gradually increased until a balance between the magnetic pull and the gravitation pull was established; at this instant the armature, fig. 13, was turned through an angle of about 38° relatively to the field magnets, and armature, fig. 14, through about 26°; this angular deflection was the same at all currents. The following table gives the weights and corresponding currents for each, W^G referring to the Gramme and W^P to the Paccinotti arrangements:—

Current in ampères.	Weights in ounces.	
	W^G	W^P
1·21	17	60
2·7	26	200
4·1	36	288
6·82	54	407
8·14	60	444

These figures are instructive although not very conclusive, since this model does not represent the exact shape of either type of armature core, but the difference in the statical effect is very great, nearly as one to eight, owing to the proximity of the iron cores when projections are provided.

Dynamically, also, we find that the Paccinotti core offers advantages, as will be seen by reference to the researches and experiments made by Prof. Silvanus Thompson and recorded in his admirable treatise on "Dynamo-Electric Machinery." Mr. Esson's experiments on this subject are also exceedingly interesting, the results of which were embodied in two articles in the ELECTRICAL REVIEW, Vol. XVII.

Whether the Paccinotti armature core is really superior to the cores of the Gramme or Siemens generators is still a moot point with certain makers, but the mechanical advantages of this type of armature core for tramcar motors are very considerable; it is far superior weight for weight, and with equal expenditure of energy when used in motors which have to give

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a great statical effect, and the projections are moreover very useful for holding and protecting the wire coils of the armature.

With regard to the general principles of construction the same rules hold good for motors as for dynamos. Wrought iron will be preferred to cast iron for magnets, since the latter metal has a much smalier magnetic capacity, and therefore a greater volume or weight of iron and copper is necessary to give the same effect. All the precautions as regards avoiding Foucault currents must be taken in motors as in dynamos.

Shunt motors are not suitable for tramcar propulsion, because in starting and mounting inclines the armature alone will get the excess of current, the field being constant.

Series motors give all the advantages for mounting gradients and for starting, but they race on the level or down slight slopes.

Compound wound motors combine the advantages of both the series and the shunt machine; but when considerable variations in speed and power are desirable, then we have to provide greater margins than the ordinary compound winding offers, if we wish to avoid the use of wasteful artificial resistances.

DOMESTIC ELECTRIC LIGHTING.*

By W. H. PREECE, F.R.S.

ELECTRIC lighting, on some distributive plan like that of gas, is still an event of the future in England. Other countries (notably the United States), Germany, Austria, Italy, Belgium, &c., are ahead of us, but in the electrical illumination of our houses we are in advance of all other countries. The number of private residences now lighted by electricity is very considerable.

I want to chronicle what has been done, and how it has been done. The pioneers of domestic electric lighting in England have been Sir William Thomson, Sir William Armstrong, Mr. Coope, Mr. Sellon, and Mr. Charles Moseley. Sir William Thomson used a gas engine, and worked his lamps direct from the dynamo, not only lighting his house, but his class-room and laboratory in the University of Glasgow; Sir William Armstrong obtained his power from a waterfall in his grounds; Mr. Coope used a steam engine; and Mr. Sellon and Mr. Moseley relied on secondary batteries, obtaining their power from a gas engine. Their good example has been very largely followed, and there are now a great many private houses in all parts of the country thoroughly and efficiently lighted.

Electric lighting means the utilisation for illuminating purposes of a certain amount of energy, which has to pass through various stages and forms, from its dormant condition in coal and water to its active condition in a lamp. I propose to discuss the question in each stage.

THE MOTOR.

Steam, gas, and water have been used as agents for the production of power, but petroleum has not yet had a trial in England, and wind is too uncertain to be relied upon. Water is the most economical when it has not to be paid for, gas the most convenient, but steam is the most reliable.

A simple, effective, safe domestic steam motor has yet to be introduced. Hathorn, Davey and Co., of Leeds, exhibited at the Inventions Exhibition the best that has yet been made, but it has the disadvantage of requiring a large supply of water to condense the steam. It is a vacuum-engine working at atmospheric pressure, and is, therefore, free from explosion. A simple single or double acting steam-engine of small horse-power, that shall be economical in working and not liable to break down, easy of repair, that shall work with great regularity of speed, and be easily governed, and that does not require a skilled engineer to attend to it, is a great desideratum. The Council of the Society of Arts has under consideration a plan, so eminently successful in the agricultural world, and pursued for many years by the Royal Agricultural Society, of offering prizes for the best engines designed to fill the special purpose of providing power for electric lighting purposes. The points of merit that are considered to be of the greatest importance are—

a. Regulation of speed.

b. Power of automatically varying speed to suit variation of load.

c. Noiselessness.

d. Cheapness.

The competition is intended to embrace all classes of engines—steam, gas, petroleum, &c.

The gas-engine seems best adapted to supply this want. Gas is already in use in most establishments within reach of gas works, and it seems far more natural to utilise the energy stored up in gas to generate power than to poison the atmosphere we breathe, deteriorate our valuables, and dirty our walls by burning it in air for illuminating purposes, especially as we get more light by doing so. Twenty-five cubic feet of gas will give us 1 horse-power, or eight 20 candle-power glow lamps, or 160 candle-power in all; but five 5-feet burners will give only 75 candles when burnt in air in ordinary burners. Gas-engines are within the intelligence of butlers, gardeners, and coachmen; they are always ready for work; they attain their maximum efficiency at once; they can be stopped in a moment. In spite of an oppressive monopoly nearly as bad as that of the telephone, they are rapidly coming into favour, and when the present patent expires, they will doubtless receive very great improvement, and much greater development.

In England the opportunities of using water-power are few and far between; in Scotland, however, the case is different. There several persons have utilised the water stored up in lakes. Sir John Fowler has lighted his Highland home by using three turbines of 12 horse-power, which, night and day, work dynamos. A 5-inch pipe from an artificial lake gives a head of 310 feet.

THE DYNAMO.

The relief which the practical world receives from the removal of the burden of a monopoly is well illustrated by the advances made in dynamos. The expiration of the Gramme patent was the signal for energy everywhere. Not only has the construction of the instrument been vastly improved mechanically, but its output has been trebled, and its price reduced to one-third; so that the dynamos of to-day are nine times better than they were during the existence of the patent. We are chiefly indebted to Elwell and Parker, of Wolverhampton, for leading the way. Hefner Alteneck first struck out a new path, which was taken up by Edison, and indeed has been well-nigh perfected by the high scientific attainments of Dr. J. Hopkinson, and has been ably followed by Mr. Crompton. Science has converted a crude instrument into the most perfect converter of energy that exists. Commercial enterprise has brought it within the reach of all. I have for the past two years been converting 2 horse-power into electrical energy with an Elwell-Parker dynamo that cost £30.

The improvements that have been effected are due chiefly to the more intimate knowledge that experience and study have given us of the theory of the machine. Better shaped magnets, more intense fields, more accurate proportion of parts, better copper and better iron, improved ventilation, have trebled the energy given out by each pound of copper wound on the armature. The intensity of the field has been increased five times; machines are far less troublesome; faults have become less frequent; armatures do not burst up so often; sparking at the brushes is less evident; commutators do not cut so much; heating of the coils is a thing of the past; and the ill-effects of self-induction are being eliminated.

The efficiency of a dynamo is the ratio of the energy given out in the external circuit to the energy supplied by the engine, and this in most modern dynamos exceeds 80 per cent. The out-put of a dynamo is measured by the number of watts it delivers, and this becomes a very convenient measure and indication of its capacity. Dynamos are now indicated in kilowatts (or "units," as some call them), and when we are told that such and such a dynamo is a 12-unit or a 12-kilowatt dynamo, we know it can deliver—

120 ampères at 100 volts, or
150 ampères at 80 volts, or
200 ampères at 60 volts,

according to its requirements. This also enables us at once to determine the horse-power required to drive the dynamo. 12 kilowatts means 16 horse-power, add one-fourth to allow for loss and waste, and we get 20 horse-power. Dynamos usually indicate the E.M.F. they work at when driven at a certain speed, and they have, or ought to have, the proper number of revolutions per minute engraved or painted upon them. If makers would only supply with their dynamos their characteristic diagrams we should have all the information the user wants.

Dynamos are classified into *shunt*, *series*, or *compound* wound, according to the work they have to do. The former are almost exclusively used for domestic purposes, for reasons which will presently appear. A well-constructed dynamo, kept clean and well lubricated, never overworked, should last a lifetime without much attention except to the brushes and commutator.

BATTERIES.

No isolated installation is complete without a secondary battery. It maintains regularity and uniformity of current, so as to secure absolutely steady light; it supplies a reserve of power that renders one free from accident to engine or dynamo; it supplies a store of electricity that provides the householder with a source of light at all times and seasons. Its early failures disappointed many; it was launched before the public at too early a stage of its infancy, but it is now a matured, sober, practical instrument. Sir William Thomson says:—

"My cells have worked to perfection. It is the greatest possible comfort to us in the house to have the light with satis-

* Abstract of paper read before the Society of Arts, March 24th 1886.

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factorily equal brilliancy, at all hours of night and day, and every day in the week. I have now cut off the gas at the meter, so that there is absolutely none used in the house. I have no oil lamps, and have not used so much as a single quarter of a candle within the last three months, and have the electric light in every part of the house where light can possibly be wanted by night or by day."

I can confirm every word of this. I have now had nearly two years' experience of them, and I would just as soon dispense with them as I would with my fireplaces or bedclothes.

Originally I used them as a regulator to my gas engine, but I speedily found that it was more convenient and economical to charge them during the day, and discharge them through the lamps at night. In the depth of winter I charge them every day; in late autumn and early spring three times a week; and in summer I charge only once a week. It is very easy to know when the cells are fully charged. When the charging current is put on, the E.M.F. commences at about 2 volts per cell, and gradually rises to about 2·5 per cell. It acquires its maximum only when the cells are full. The current, on the contrary, falls. The density of the liquid, which is observed by a hydrometer floating in a cell, gradually rises, and when it becomes constant, the cell is full. Several hydrometers are used. Gas is then freely given off, and the cell has a milky appearance.

On the other hand, when a cell discharges the hydrometer sinks, and when it reaches a minimum point it must be charged again. The E.M.F. also commences to fall when it is too empty, but I never allow that point to be reached. Good cells give an efficiency of 70 per cent. without losing E.M.F., and with a loss of 10 per cent. they will give over 80 per cent. The useful rate of a battery is the number of ampère-hours it will give before losing 10 per cent. of its E.M.F. It is quite possible to get out of a battery all, or nearly all, the energy that we put in, but we cannot do so at a useful or economical rate. I give in the appendix a record of the charge and the discharge in my house in the month of February last, and also a record of last week's work.

The durability of these cells is most satisfactory. I see no reason why they should not last ten years at least. In fact, I believe the makers will maintain them at the rate of 10 per cent. per annum.

The faults that I have experienced are very few and rare. Short circuiting from peeling or buckling are things of the past. I have never seen a case of "treeing." Occasionally the connections develop resistance, and get hot, but this is solely due to neglect; they require attention and cleanliness.

It sometimes happens on high days or holidays that more current is wanted than can advisably be drawn from the cells; the engine is then allowed to run as well, but if the current developed by the dynamo is in excess of that used in the house, a few cells have to be taken off the battery, which is readily done by a switch, in order to maintain the E.M.F. in the house at its normal point. It is impossible, in fact, in the house to tell whether the engine is going or not. If it happens that the engine is kept continuously running, while the batteries are in action, special steps have then to be taken to prevent the cells from being irregularly charged, by changing the idle cells periodically.

A secondary battery acts perfectly as a regulator as long as it is well charged; its resistance is so small compared with the lamp circuit that it may be regarded as nothing, but if from any bad contact, fault, or weak cells, the resistance becomes appreciable, fluctuation in the light becomes evident, and it ceases to act efficiently.

The latest form of cells are exhibited on the table, and they are now so well-known that they need no description in this paper.*

Primary Batteries.

I have had no practical experience of their employment for domestic lighting, nor have I seen a house lighted up by them; but I believe there are several installations at work, and I am sure the Society will be glad to hear in the discussion some facts from those present.

Lamps.

No great progress can be chronicled in lamps like that in dynamos and secondary batteries. Their price remains very high. A good standard glow lamp has not yet been devised. I should like to see a 10-candle lamp working under a pressure of 50 volts, and requiring half an ampère, that would mean the absorption of 25 watts, or 2½ watts per candle. Its life would not be very great at present, but if it were cheap enough, one would not mind frequent renewals.

There is great variety of practice in determining the number of volts best adapted to work an installation. The conditions that regulate a central station system are quite different from those regulating domestic lighting. The former requires high pressure to reduce the weight of the mains, the latter requires low pressure to reduce the number of cells. Both are governed by economical reasons. I recommend 50 volts for home lighting. I tried originally 31 volts, but I had to increase the pressure, for the low volt lamps took too much current from my cells.

Makers of lamps seem to consider that there is great credit in securing long life. Unfortunately, glow lamps deteriorate sadly with age. The carbon wastes inperceptibly away, and we are scarcely conscious of the fact that, after 200 or 300 hours, the lamp gives only half the light it did at first. The fact is lamps last too long. I have been relegating my old lamps to the bedrooms, but they will not die, and I have been obliged to remove them "ere their time." The price of a lamp should be such that we could afford to give them a short and merry life. Long life is therefore an objection.

The efficiency of a lamp is generally taken to be the number of watts it consumes per candle per 1,000 hours of life; but a good measure of efficiency would be the number of hours it took to lose 10 per cent. of its normal light when absorbing 2½ watts per candle.

Some interesting experiments were recently made in Berlin on this point by Mr. Wilhelm Siemens, who showed that in 800 hours an unflashed carbon, consuming 5 watts per candle, lost 37·7 per cent. of its light, falling from 19·9 candles to 11; while a flashed carbon, consuming 3·2 watts per candle, lost only 12·7 per cent., falling from 17·5 candles to 14·5. The resistance of the former increased 12·7 per cent., of the latter only 4·2 per cent. The process of flashing carbon is a process by which pure hard grey carbon is deposited upon the carbon filament by heat, decomposing some hydrocarbon gas with which the globe is filled. This deposit of carbon enables the filament to acquire a brighter surface, and attain a higher temperature before commencing to disintegrate, and therefore it gives a higher efficiency, for the amount of light given out depends simply upon the temperature.

A glow lamp, when incandesced, seems to lose its carbon mass steadily and regularly. The carbon molecules fly off, and are projected against the sides of the globe, where they adhere, and cloud or discolour the glass, so that the light is diminished in two ways—first, by the wasting of the carbon, and, secondly, by its being deposited upon the glass, and preventing its radiation. The resistance increases owing to the diminution of the sectional area. This goes on until eventually, at some weak point, the mechanical strength is reduced to such a point that the filament becomes too weak to bear the slight strain upon it, and it breaks; or the density of the current becomes too high, and it dissipates away like a bright star, leaving a gap across the filament. This weak spot can often be detected by its brilliance before the lamp goes.

There is a critical point in all lamps when a change of state occurs in the carbon filament. It is shown by the appearance of a beautiful blue effect pervading the whole globe. It occurs at some point between 1 and 2 watts per candle. It should be determined for each kind of lamp.

I have an example of a lamp destroyed by lightning in Mr. Elwell's house, near Wolverhampton, which shows very beautifully the destructive effect on carbon of very high E.M.F. The globe is converted into a beautiful mirror.

Lamps fail in giving their light occasionally from having an imperfect vacuum. This is very easily detected by feeling the globe. If the vacuum is bad it gets quite hot. Mr. J. T. Bottomley showed that a wire became red hot when the air was exhausted from the globe, though it was only 80° C. when the air was in. Occasionally, but very rarely, lamps explode with a loud report when the current is first put on. This is, perhaps, due to a slight leakage of air making an explosive mixture with the residual gas.

At the present moment, both the nomenclature and the efficiency of glow lamps are in a very unsatisfactory state, and we are buying pigs in a poke at a very high price.

Mr. Edison adopted the very meritorious plan of determining the E.M.F. which would give his lamps a life of 1,000 hours, and the current that would give it the normal light. If this were done by every maker, it would be easy to determine the life at any other E.M.F., or the light at any other current, for the former varies with the twenty-fifth power of the E.M.F., and the latter with the sixth power of the current.

Considerable difference of opinion exists as to the character of the globe enveloping the carbon filament. Some like them clear, some like them ground; others envelope them in shades—generating light simply to choke it; while others, at a great loss, make the globe of a beautiful opal glass. It is very objectionable to have the optic nerve irritated by a brilliant glowing filament; but it is equally absurd to produce a good thing and then strangle it. Grounding and shading mean loss of light. Lamps can be placed so high that they need not affect the eye, and if they do, the light can be so reflected as to be useful elsewhere. The art of lighting a room is to flood it with light without the delicate eye being offended with the direct rays from the source of light.

An essential feature of a good lamp is a good holder, by which lamps can be readily removed and renewed. Mr. Alfred Swan has recently introduced a "vitrite" holder which leaves little to be desired.

Cuts-out or safety valves are essential to the security of a house. They should be fixed on every circuit.

Fittings.

The comfort and pleasure of a house depends upon its fittings. It is here that taste has its sway and art its swing, and the two are regulated only by the balance at the bank. Sir David Salomons, who has spared no expense in obtaining energy at Broomhill, has exercised wise economy and rare taste in fixing his lamps. They are so suspended by their own conductors that in daylight you do not see them, but when darkness comes they spring into light like beautiful stars floating in the air. No one has taught us so much in this direction as Mr. Tayler-Smith, whose portable lamps and useful appliances were so much ad-

* Until January of this year I had been using Elwell-Parker cells at my house, but I am now trying the E.P.S. form, having removed the former to the Post Office.

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mired at the Healtheries and at the Inventions last year. My house is full of them. I have lamps everywhere, and I can get light wherever and whenever I want it.

WIRING.

No one must imagine that electric lighting is absolutely safe from fire. It is very simple to secure safety if the rules and regulations to avoid fire risks be carefully followed. The simplest rule is to use nothing but the best insulated wire, and to employ none but experienced men to put it up. All accidents that have occurred have arisen from careless wiring and ignorant handling.

In a new and growing business like electric lighting, competition should be very guardedly resorted to. There are firms of repute who are experts, and who can be trusted to carry out everything, but they are few. Protection should be procured by careful specification and constant supervision. The electrical engineer is as essential to the success of the building as the architect, and he should be engaged professionally. There is a great deal too much work done by the tradesman alone, and too little left to the expert. The design of the circuits of a house, the dimensions of conductors, the quality of the materials used, the provisions against fire risks, the testing of the work done, the adaptability of means to an end, should come within the province of the professional adviser, and not be left to the successful competing contractor, however eminent the firm may be.

METERS.

The most efficient, reliable, and simple voltmeter that I know is Cardew's, and Siemens's electro-dynamometer remains master of the situation.

Ferranti's meter is a most admirable adjunct. In my house one measures the current going into the batteries, and another measures the current coming out, so that I am able to keep an accurate debtor and creditor account against my battery. The result for February is seen in the appendix. How far these meters are accurate within a wide range has yet to be determined. They are certainly more accurate than gas meters, and they are more easily comprehended.

When electricity is laid on a house it can be used for other purposes besides illumination. Mr. Sellon uses it for heating: a current of fresh warmed air passes through a coil at a temperature of about 180° Fahr. and warms water-closets and dressing-rooms.

I am now trying charming little portable lamps, worked by secondary cells, made by Mr. Pitkin, which enables me to visit my cellars with comfort.

TESTING.

It is most desirable that every means should be adopted in a house to test the condition of the wires and apparatus constantly. Any incipient fault in a wire would speedily develop into a serious trouble under the influence of such powerful currents as electric lighting requires. It is therefore essential to detect its existence at once.

It is often said that it is all very well for me—an expert—to rejoice over the success of electric lighting in my own house. It would be a disgrace if it were not so, but there are non-experts who have been equally successful. As regards cost, it comes out just twice that of gas; for, though I burn no more gas than I burnt before, I have more wages to pay; there are also repairs to machinery, and the purchase of oil and waste. The lighting of my home cost me, in 1885, £60 0s. 6d.

	£	s.	d.
Gas	£34	9	0
Oil	2	5	0
Waste	0	12	0
Brushes	0	17	0
Repairs	4	9	6
Wages	10	8	0
Lamps	7	10	0
	£60	0	6

Now, if we charge against this the value of steady light, pure air, no heat, absence of matches, candles and oil, comfort, durability of pictures, decorations and books, no painters, cleanliness, cheerfulness, health, gain of time, long life, there is little doubt on which side the balance will appear.

APPENDIX.

TABLE I.—E.P.S. CELLS AT GOTHIC LODGE DURING MONTH OF FEBRUARY.

Date.	E.M.F.	Ampère hours. Put in.	Ampère hours. Taken out.	Remarks.
1	50·7	121	55	
2	51·8	64	46	
3	51·8	72	44	
4	52·8	72	38	25 cells, 15 L type.
5	51·8	81	50	
6	52·0	91	53	
7	52·2	—	41	Internal resistance 0·0015ω per cell.
8	52·2	140	44	
9	52·3	—	50	
10	52·2	110	47	
11	51·8	—	50	Total put in, 1,747 ampère hours.
12	51·8	92	30	
13	52·0	102	37	
14	52·0	—	44	Total taken out, 1,251 ampère hours
15	52·0	123	44	
16	52·0	—	55	
17	52·0	116	47	
18	51·8	—	40	Efficiency 72 per cent.
19	52·0	102	47	
20	52·0	61	53	
21	52·0	—	42	Average hours of lighting—5.
22	52·0	118	34	
23	52·0	—	44	
24	52·0	110	44	Average number of lamps burning—12.
25	52·0	—	45	
26	52·0	115	45	
27	52·0	57	41	
28	52·0	—	41	

TABLE II.—CHARGING BATTERIES.

Date.	Hour. h. m.	E.M.F. volts.	Current. ampères.	Hydrometer readings on cells. No. 2.	No. 5.	No. 14.	No. 17.	No. 20.	No. 25.	Remarks
March 18th	8 0	57	16	1,160	1,165	1,150	1,150	1,150	1,150	*March 18th.* Reading by meter 2,895,580
	9 0	57	18	1,160	1,165	1,150	1,150	1,150	1,150	Previous reading 2,801,650
	11 0	59	19	1,165	1,170	1,155	1,155	1,155	1,150	
	12 0	60	19	1,170	1,175	1,160	1,160	1,160	1,155	93,930
	1 0	62	19	1,175	1,180	1,165	1,165	1,165	1,165	Constant of meter, 630.
	2 0	67	19	1,175	1,180	1,170	1,170	1,165	1,165	9,930 ÷ 630 = 149 ampère hours put into batteries.
	3 0	68	17	1,175	1,180	1,170	1,170	1,165	1,170	
	4 0	69	16	1,175	1,180	1,170	1,170	1,165	1,170	Average charging currrent = 19a
„ 19th	...	...	...	1,170	1,175	1,165	1,165	1,160	1,160	
„ 20th	8 0	56	16	1,165	1,170	1,155	1,155	1,155	1,150	*March 20th.* Reading by meter 2,957,760
	9 0	57	18	1,165	1,170	1,160	1,155	1,155	1,150	Previous reading 2,895,580
	10 0	59	20	1,170	1,175	1,165	1,160	1,160	1,155	
	11 0	62	20	1,170	1,175	1,165	1,165	1,160	1,155	62,180 ÷ 630 = 98 ampère hours put in. 62,180
	12 0	67	19	1,175	1,180	1,170	1,170	1,166	1,160	
	1 0	69	16	1,175	1,180	1,170	1,170	1,165	1,165	Average charging current = 19·6a
„ 21st	...	...	...	1,170	1,175	1,165	1,160	1,160	1,155	Discharge, 8·5 ampères per degree.
„ 22nd	...	...	...	1,165	1,170	1,160	1,155	1,155	1,150	

DISCUSSION.

The CHAIRMAN said he thought on a former occasion Mr. Preece had scarcely been so enthusiastic in favour of electric lighting as he had been that evening. He had spoken from his own experience, and shown that electric lighting had now come within the reach of a great number of people, if not of all; and he felt convinced that the public would no longer submit patiently to the restrictions which had up to the present stood in the way of this new industry. The underground miner was very much troubled for want of light, and it had been lately his duty to inquire into this

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matter. Mr. Preece told them he had only now to take a large pocket battery into the mine, and when it was getting exhausted turn out the fluid, and fill it up again from a flask out of another pocket. In this respect he thought Mr. Preece had drawn rather a highly-coloured picture; but he would not discourage either him or the miner, in the hope that Mr. Pitkin, Mr. Blumberg, Mr. Skrivanoff, and others, would one day furnish an electric light which would do everything which was required in mining.

Sir FREDERICK BRAMWELL, F.R.S., said he could not accept Mr. Preece's ideas on political economy and some other matters, quite so readily as he did his views on electric lighting. He complained that the term horse-power was unphilosophical and illogical, but he did not say why it was so; except that it was 746 times something else which was philosophical and logical. He could not help feeling that this was a paper for the upper classes, for gentlemen living in convenient detached houses, with gardens and gardeners, and such persons, no doubt, could indulge in the electric light; but he was one of the unfortunate people who had to live in London where they could, in a house in a row, and he wanted to know why he was to be debarred the use of the electric light. One thing which horrified Mr. Preece was monopoly. But if a man invented something which had never been known before, after years of trouble and large expenditure, why should he not be protected? Mr. Preece was a Government official, and until the year 1882 the Government were not amenable to royalty, but could take any man's patented invention, and use it without payment. By the Act of 1882, however, the Government had no longer that power, and he could not help thinking that this might partly account for Mr. Preece's hostility to patent monopolies. He said he wished someone would invent a lamp which would do so and so—but why should a man invent, if he were not to get anything out of his invention? If such a lamp were brought out, and the inventor were getting something out of it, Mr. Preece would at once be down upon him, and say it was an obnoxious monopoly.

Sir RICHARD WEBSTER, Q.C., M.P., said there was one point on which he should like some information, and that was the cost of installation, because this was a most important consideration, both from the point of view of those who could establish private installations of their own, and also from the public point of view, where electricity was to be supplied to a large number of houses. For example £7 10s. for lamps seemed a large sum; very possibly Mr. Preece in his good nature had been experimenting for the benefit of mankind, and had had a great many breakages, but £7 10s., at 5s. per lamp, would give 30; he had 58 lamps in his house, from 12 to 15 being used nightly, on an average, and perhaps 20 to 30 on special occasions, and he certainly had not broken six in two years. Apart from the cost of installation, he believed that when a gas-engine was used in a house where there was an intelligent man servant who could attend to it, the actual running of the electric light would not cost more than gas. He was satisfied that he did not spend more now than he used to spend on gas, oil and candles. The most interesting portion of the paper, from the public point of view, was no doubt the question of the extension of electric lighting to those who were not able to have their own installation in the way which had been described. The great reason why there was so much hesitation among people of moderate means to adopt electric lighting was because they had already paid a considerable sum for gas pipes and fittings, which would be thrown away. Now, since the passing of the Electric Lighting Act, there had been thousands of houses built, many in squares and large clusters, to all of which electric lighting might, and to many undoubtedly would, have been applied but for the absurd restrictions which had been referred to. He did not suppose one in a hundred had even been wired for electric lighting, though it might have been done easily and cheaply, so that all in a square or gardens might have been supplied from a central station. One thing they desired to do was to cheapen the cost of installation; that the money which was now expended in gas fittings should be devoted to wires, &c., which could be done much more economically in a new house than afterwards. If £500 or £700 were spent in fitting up one house, a hundred or two more would enable two or three to be supplied from the same source. The result would be that electric lighting could be supplied from a central station at very little more than the cost of gas. In a few years it might be quite as cheap, and then the only difference would be the cost of the wires and lamps in the first instance as compared with gas fittings. He hoped the present meeting and the public generally would strengthen the hands of the society in supporting Lord Rayleigh's Bill, and that such pressure would be brought to bear on the Government of the day as would lead to the removal of those restrictions which had hitherto stood in the way, and that then electric lighting might be brought within the reach, not of the rich only, but of those who were quite as deserving, and who had not the same facilities at their command.

Mr. CROMPTON said it was very difficult to state the cost of installation, as it depended so much on varying conditions. For instance, he had to estimate for lighting such a building as Hampton Court Palace, where the wires alone would cost about £3 per light, and on other occasions for mills and factories where the same item would be as low as 4s., so that it was almost impossible to give anything like an average. One reason why the lighting was so costly at present, was that the industry was such a small one; there were not men qualified to do the work in every town, as there were gasfitters; and in the case of a house like Sir John Fowler's, in the far north, he had to send almost to the other end of England, not only for the workmen, but for those who superintended the work, so that on a job of moderate size, the expenditure for wages was very heavy. He could also agree with Sir R. Webster that the cost mentioned by Mr. Preece seemed excessive; he seemed to have spent as much on gas in one year, with a 2 horse-power engine, as he (Mr. Crompton) did in two years with a 3½ horse-power. He had 68 lights, of which from 20 to 25 were usually in use, and his cost per annum for gas was only £15. His experience with lamps was also the same. No doubt if you made experiments you might break a great many lamps. He was supplied with enough lamps to keep his place going, even supposing they lasted the short time experimental lamps usually did; but he found that if he used the lamps originally invented by Mr. Swan, which still held a high position, a breakage of 5 per annum was the maximum. With regard to house to house lighting, which was no doubt the most important point, it was quite true that the Electric Lighting Act had had much to do with keeping back this industry. But it was only fair to say that it was only within the last six months that they had at command such appliances as would have enabled them to carry out general lighting at all. If it had not been for the excellent meter of Mr. Ferranti, there would have been no means of measuring the supply in any trustworthy manner, and any attempt to supply the light, apart from a meter, would have led to insufferable difficulties. Having tested the Ferranti meter very carefully, he had come to the conclusion that it was quite good enough for present purposes, and its perfection had removed one great stumbling block out of the path of co-operative electric lighting.

Mr. SELLON remarked that the interest in this subject was evidenced by the crowded state of the room. He first introduced electric lighting into his house in 1881, and ran about 110 lights, the average number used per night being about 50. These were all kept going by secondary batteries, the gas engine of 3½ horse-power being run a few hours per day. The cost per lamp per hour was ¾d., which would bear out Mr. Preece's statement of electricity being twice the cost of gas; but there were far greater considerations than the mere cost. Since 1881, he had never had to expend anything on paint, whitewashing or decoration, and this formed a substantial item on the credit side. Much scepticism had been expressed as to the life of secondary batteries, and of course there were good and bad batteries—good and bad manufacture, and good and bad treatment; but with a well-made apparatus, treated with ordinary care, the difficulties disappeared. He could show batteries made four years ago which were still in perfect working order, and to the inexperienced eye they looked as good as on the day they were put down; the experienced eye would perhaps detect a depreciation of about 10 per cent., but this was not much on apparatus of such a class.

Sir DAVID SALOMONS, Bart., said he had no connection with any one engaged in electric lighting, and he spoke entirely as one of the general public. He thought Mr. Preece's estimate of cost was extremely small, because he had included nothing for depreciation; the installation would cost £600 or £700, and on that 10 per cent., or 7½ per cent. at the least, ought to be charged. He used electricity on a large scale, employing on an average about 100 lights for 230 or 240 days in the year, and the expenditure did not exceed, with a sinking fund, £200 without interest, or £230 with it, and he considered that extremely low as compared with £60 without a sinking fund, or any other allowance. He went on to describe a method by which he could detect with certainty whether any lamps were alight after a proper time, and said that, after a few discoveries of that kind had been made, he had no further trouble on that head. There was another reason why 100 or 150 volt lamps were desirable, apart from the risk of heating the lamps or destroying them. Many persons, if they had four lamps fitted up in a room, would add to or double the number, never dreaming that this added to the difficulty or danger; now, with 100 volt lamps this danger was much lessened, and besides this the lamps lasted much longer. He knew some people held a different opinion, but he had proved his view by experience. The secret was, as Mr. Preece had pointed out, that the low volt lamp got dark after a certain time, and more E.M.F. had to be used to drive the current through it, which led either to waste of energy or loss of light. The filaments in the 100 volt and higher lamps were thinner, and therefore there was a much less quantity of carbon deposited on the same area of glass. Such lamps would run from 800 to 1,000 hours without appreciable diminution of light.

Mr. PREECE, in reply, said, as Sir Frederick Bramwell had left, he would not waste time in trying to convince him of the superiority of the watt to the horse-power; he would only say that instead of his knowledge of a watt being that it was $\frac{1}{746}$ of a horse-power, his knowledge of a horse-power was that it was equal to 746 watts. He did not think Sir Frederick had quite grasped his meaning with regard to monopolies; what he objected to were grinding, grasping monopolies, such as in a few instances were a disgrace to this country. But it was quite a mistake to suppose that his ideas were in any way governed by his official position, or by the new Patent Act. He belonged to a department of the Government which always had recognised patents, and there never was an invention brought to the Post-office, patented or unpatented, by anyone, which was not well and amply rewarded. Duplex and quadruplex telegraphy, automatic apparatus, and other things had been brought to the Post-office, and nothing had ever been adopted which had not been more amply remunerated than it would have been by a private commercial company. With regard to the cost of installation, he could not say what it had cost him, but he could fit his house up again, or any house like it, for £7 10s. per lamp. A comparison had been drawn by Mr. Crompton between his cost for gas and that which he

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(Mr. Crompton) incurred, but when it was remembered that he had to pay 4s. 9d. per 1,000 cubic feet, which was probably nearly double that paid by Mr. Crompton, it was no wonder that his total expenditure was nearly double. It was quite true that the charge for lamps was high, for the reasons which had been suggested; he had been experimenting very freely, but, since last June, Mr. Upton, the manager of the Edison electric light works in New York, who came to see him, and regretted that he had not a single Edison lamp, sent him a present of 100, and out of 56 he had only lost three since last June. It was a very good lamp, although there was some loss of light after a time. Sir D. Salomons wanted him to allow 10 per cent. for depreciations, but he preferred following the Government system. They paid for everything out of revenue, and had no capital account on which to charge interest. Within the last two years 29,000 miles of wire and 2,000 or 3,000 new apparatus had been put up to meet the contingencies of the sixpenny telegrams, and, although this cost nearly £500,000, it was all paid out of revenue. In the same way he had fitted up his house out of revenue, the money was gone, and he should not dream of putting by 10 per cent. to bring it back again at some future time.

The CHAIRMAN then proposed a vote of thanks to Mr. Preece, which was carried unanimously, and the meeting adjourned.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 1) BILL.

House of Commons, March 26th.

LORD RAYLEIGH, in rising to move the second reading of this Bill, said that it was commonly but erroneously supposed that electric lighting was a recent invention. It was, in fact, discovered at the beginning of the century by Davy, who was well aware of the powerful character of the light, which by contrast seemed to be intensely blue, but was really less blue than the daylight. More recently, the present Mr. Justice Grove, then an ardent experimentalist, showed how a reading lamp could be constructed by passing electricity through a spiral wire at a red heat. The difficulty in the practical development of the art lay almost solely in the production of the electricity, which at that time could only be produced by batteries. But by the introduction of the dynamo machine the art of electric lighting attained a greater and greater development, and at the present time had so nearly attained perfection that 93 per cent. of the whole mechanical power was converted into the electrical form. The next difficulty was in employing electricity on a small scale; but the discoveries, almost simultaneous, of Edison and Swan, went far towards overcoming these difficulties. The result naturally was that electricity was supposed to be rapidly superseding gas, and gas shares accordingly became much depreciated in value. Then various schemes came before Parliament for the supply of the electric light, and the Act of 1882 was passed, which was termed an "Act for facilitating and regulating" the use of electricity for lighting and other purposes. But it was proposed to effect the object of the Act by more oppressive regulations than were ever before applied to an industrial undertaking. The burden of complaint lay in the 27th clause, by which local authorities should have the option of compulsorily purchasing undertakings for electric lighting after 21 years. In the event of disagreement as to the price, the question was to be submitted to arbitration, and it was provided that the price to be paid for the undertaking, plant, &c., should be its value at the time of purchase—i.e., when the machinery might be much worn or even obsolete. What was still more surprising was that when the Bill was first introduced into the House of Commons the period was seven years. It was, however, extended by the Select Committee of that House to which the Bill was referred to 14 years, and their lordships further enlarged the time to 21 years. If the terms of purchase had been reasonable the mere shortness of time might not have constituted an obstacle to the working of the clause. But no capitalist would care to invest his money in electrical enterprises on such terms as the Act imposed. Those terms in effect were that if the enterprise failed the loss should fall exclusively on the capitalist; but if it should be successful the local authorities should have power to step in and buy the concern on utterly inadequate terms. How could such a clause permit the proper development of any scheme of electric lighting? It might be that the powerful interest of the gas companies was arrayed against electric lighting enterprises. He was unwilling to believe that Mr. Chamberlain, who was then President of the Board of Trade, was actuated by anything else than a desire for the public interest. It was a difficult and wide question how far local authorities could usefully enter into industrial enterprises of this kind. He would not enter into that question, though he would remark that the electric light did not stand in the same position as water supply, which was an absolute necessity, or even as the manufacture of gas, of which almost as much was known as could be known. At the time the Act was passed it was generally supposed that the electric light would be a great success, and the Board of Trade desired that the benefit of that success should be shared by the public and that it should not go entirely to private companies. It seemed to him that there was too much jealousy at the present day of a private company making large profits. Most undertakings were more or less of a speculative character, and if some were great successes others were miserable failures, so that one ought to be balanced against the other. The promoters of the Act in endeavouring to advance the public interest really inflicted great injury on the public by preventing them from having any chance of getting the electric light for many years. Although he believed a great mistake was made at the time of the passing of the Act in 1882, he was willing to admit that the subject was one of considerable difficulty. The Bill was not seriously debated in either House of Parliament, but it had the advantage of consideration by a Select Committee of the House of Commons, under the presidency of Mr. E. Stanhope. That Committee took the evidence of experts and heard counsel who represented the various interests involved. He must go further and admit that some of the witnesses on behalf of electric lighting examined before this Committee seemed to think that 21 years might possibly suffice as a minimum period, not, however, in conjunction with such terms of purchase at the end of the period as those embodied in the Act. From another point of view he thought they need not altogether regret that something in the nature of a wet blanket was thrown by the Act over the feverish speculation at that time. During the last two years he could not think the Acts had done any great public injury. Many mines and large ships had been lighted by electricity, and the last two years had been a very favourable time in other respects. Labour had been cheap and capital could easily have been obtained on reasonable terms. As soon as it became clear that matters were at a deadlock, endeavours were naturally made to obtain some relaxation of the very stringent provisions of the law. At the suggestion of Mr. Chamberlain, who was then at the Board of Trade, a Committee was appointed of which the noble lord opposite was chairman, and among its members were Sir Frederick Bramwell and others who were well qualified to advise in matters of that kind. The present Bill was, in fact, the outcome of the deliberations of that Committee. When they considered in what directions it would be possible to obtain a relaxation of the present law, the most obvious one that suggested itself was a prolongation of the period of 21 years, more particularly if that prolongation could be accompanied by some less unfavourable terms of purchase. This was the view of the matter which had commended itself to his noble friend who had communicated the second Bill to the trio now before the House. If the question were merely one of raising a large amount of capital in order to start an enterprise of this kind once for all, it was likely enough that such a relaxation as he had spoken of would meet the circumstances of the case. But they could not shut their eyes to the fact that, in so experimental an enterprise as electric lighting must be for many years, it would be impossible for a company to lay out a large sum in the first instance, in the full confidence that they would obtain a fair remuneration for their outlay. They would establish the system on a comparatively small scale at first and then would gradually extend it. In that case it was obvious that a comparatively small capital would be required in the first instance, but from time to time they would have to go into the market in order to raise fresh capital. In what position would the company be to effect that object? After a considerable fraction of their terms had elapsed they would be in such a position that it would be impossible for them to attract fresh capital to the enterprise. Moreover, the interests of the public would be by no means served during the latter part of such a term. During the later years the company would hesitate greatly about embarking on any improvements or extending the area of their operations. After considering the objections which he had endeavoured to place before their lordships, the Committee came to the conclusion that a solution of the question could not be found in that direction, and they proposed that the two competitors, lighting by gas and lighting by electricity, should be put on the same footing in respect not only of privileges but also of obligations. The obligations imposed by the Bill were more severe than anything in the existing law. One of the clauses relating to the compulsory supply of electric light provided that the company should be required to supply electric light at any point within 25 yards of their mains. The important question of the raising of additional capital was provided for by the adoption of the corresponding provision from the Gas Acts known as the auction clauses. The object of securing to the public part of the benefits of the undertaking was, to a great extent, obtained under the provisions of the Bill by the adoption of what was known as the sliding scale of the Gas Acts. If a company were able to supply gas at a lower rate, then in accordance with that they would be at liberty to increase the dividends paid to their shareholders. By this arrangement a company would have every inducement to consider efficiency and economy, and at the same time, if circumstances were favourable, both the public and the company would be benefited. At the present stage of the question he did not wish to commit their lordships further than to the opinion that the obstacles should now be removed which practically forbade the attempt to supply electricity publicly on a large scale under the Act of 1882. If the suggestion of the noble viscount who had another Bill on the same subject were adopted, the exact form of that remedy might be well left to a Select Committee of that House, or of both Houses of Parliament. What he particularly wished to emphasise was that too much time had been lost already, and it would be a matter of great regret if further delay was allowed to intervene so as to prevent a fair chance being given to this most interesting application of modern discovery and invention, which promised to do much to relieve the gloom and unhealthiness of life in our great cities. The noble lord concluded by moving the second reading of his Bill.

LORD HOUGHTON said that Her Majesty's Government had no objection to the second reading of this Bill provided that if the motion of the noble viscount to refer the two Bills to a Select

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Committee should not be carried, the noble lord would defer the committee stage of the present Bill till the Government Bill on the same subject had passed through Committee.

The Bill was then read a second time.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 2) BILL.

VISCOUNT BURY, in moving the second reading of this Bill, said that although it went in the same direction it did not go so far as that of his noble friend. The Bill to which the House had just given a second reading was a companies' Bill, as it put the undertakings of the electric lighting companies on equal terms with those of the gas companies. But he believed that the interests of the public would be best served if a term were given at the end of which the electric lighting undertakings should belong to or should be capable of acquisition by the local authorities. His noble friend, on the other hand, gave the electric lighting companies a perpetuity like the gas companies. The term fixed by the Bill which he was now moving was 42 years. He had no objection to the greater part of his noble friend's Bill, but it would be in the interests of the public that both should be referred to a Select Committee. If the Government had prepared a Bill on this subject why had they not brought it on before instead of wishing to delay these Bills? Legislation was urgently required on this subject, as the Act of 1882 had made electric lighting altogether an impossibility. He did not know of a single place which had been lighted under it. It had entirely frightened capitalists away, as no one would invest money in a concern which could be sold for the price of old iron at the end of 21 years. He proposed to give a term of 42 or 63 years, at the end of which period the local authority would have to pay the price of a going concern.

The Bill was then read a second time.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 1) BILL.
ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 2) BILL.

VISCOUNT BURY moved that these two Bills should be referred to a Select Committee. He said that the matter must be dealt with to a great extent on expert evidence. The principle to which he attached importance was that the term for the purchase of the undertakings should be extended from 21 years to a much longer period, and the object of the Committee would be to inquire from experts what was the shortest term that could be given for working which would permit of capital being raised for electric light undertakings.

LORD HOUGHTON said that Her Majesty's Government had no complaint to make against either of the noble lords; on the contrary, they quite admitted that the present position of electric enterprise fully warranted them in bringing in these Bills. Although the Electric Lighting Act of 1882 contained some very valuable provisions, nevertheless he did not doubt that the time had arrived for relaxing some of its most stringent clauses. The Board of Trade had, in relation to this matter, to consider three separate interests—those of the inventors, those of the local authorities, and those of the public. Her Majesty's Government believed that electric lighting had a very brilliant future before it, provided sufficient security was taken that new and perpetual monopolies were not created. He objected to the Bill of the noble lord on the ground that although it was politely called an amendment Bill it was really intended to entirely destroy the Act of 1882 and to establish a new series of vested interests. Again, the Bill of the noble viscount would create a more dangerous because a more insidious form of monopoly. What Her Majesty's Government were prepared to do in their Bill was to extend the *maximum* term during which a provisional order should remain in force from 21 years to 30 years, and with the consent of the local authority to 42 years from the date of the concession, the companies to have three months' notice in order to enable them to arrive at some new arrangement. Her Majesty's Government, however, could not consent to their Bill being referred with those now under discussion to a Select Committee. He therefore appealed to the noble viscount to withdraw his motion for referring these Bills to a Select Committee, or at all events to postpone it until he had seen the Government measure which would be laid before the House in a day or two. In his opinion, this subject could be better discussed in Committee of the whole House than by a Select Committee.

VISCOUNT CRANBROOK asked whether it was intended that the three Bills should be referred to a Select Committee.

LORD HOUGHTON replied in the negative.

VISCOUNT BURY remarked that an extended term of 30 years would not be sufficient. If the noble lord did not intend that the Government Bill should be referred to a Select Committee, and refused to agree to a further extension of the term beyond 30 years, he should go to a division upon his present motion. If the noble lord, however, would agree to refer the Government Bill to the same Select Committee to which these Bills were to be sent he would gladly withdraw his motion.

The DUKE of RICHMOND and GORDON said that when the House had seen the Government Bill it would then be for their lordships to decide whether the three Bills should be sent to the same Select Committe.

EARL GRANVILLE was understood to assent to that proposition.

The discussion upon the motion was then adjourned.

REFORM IN THE FRENCH TELEGRAPH DEPARTMENT.

MONS. GRANET, the Minister of Posts and Telegraphs, in a recent report to the President of the French Republic, strongly urged the necessity of combining in one department the technical and traffic branches hitherto kept distinct and separate. In the course of the report he stated that when in 1878 the separate administrations of posts and telegraphs were united under one executive, the difficulty (due to the essential difference between the two services) presented itself as to the best course to be pursued: whether to adopt a slow and progressive fusion depending on the gradual education of the employés whose qualifications had necessarily to be largely increased, or an immediate blending of all the elements at all similar, postponing the fusion of those whose systems were altogether divergent.

The latter course was adopted, as it was thought that prompt and energetic measures would more readily overcome all jealousy of innovation, and the natural resistance and opposition to a reform—so wide spread—to so complete a revolution of the existing state of things.

The experiment turned out a success, so much so that to-day the separation of the two services would prove more difficult than was their fusion.

But, on April 23rd, 1883, in addition to the already existing traffic service, which, up to this date, included the direction, inspection, and control of the transmission of all correspondence whether postal or telegraphic, the discipline of the staff, and finance, there were added three fresh departments, viz., the travelling service, the maritime service, and the technical service. The first two named explain themselves. The last included the construction and repair of lines, the fitting up of offices, instruction of staff, and instrument making and repairing.

Mons. Granet gives, as reasons for uniting the technical and traffic departments—that they depend entirely on one another; that the scientific department only exists for the sake of the traffic; that the latter could not survive without the assistance of the former; that the existence of two departments, completely distinct in their officials, systems, and training, both engaged on the same work is only productive of antagonism and delay, from jealousy between the two services, and through each department being obliged to get the approval of the other on every detail connected with the work. All improvement, all advance, was thus very much hampered.

The proposal of the Minister of Posts and Telegraphs has been accepted, and the President of the Republic has decreed that from May 1st, 1886, the technical and traffic departments of the French telegraphs shall be united under one administration under the control of a council of six chief inspectors, and with the head quarters at Paris.

The principal officials of the present technical and traffic departments are to be re-appointed and re-distributed according to their rank and seniority.

THE TELEPHONE CASE.

THE UNITED TELEPHONE COMPANY, LIMITED *v.* BASSANO AND SLATER.

Judgment of Mr. Justice North, delivered Saturday, March 27th, 1886.

MR. JUSTICE NORTH: The letters patent bear date the 30th of July, 1877, and were granted to Mr. Thomas Alva Edison, a gentleman whose brilliant discoveries with respect to electricity have rendered his name famous throughout the scientific world, and they relate to improvements in instruments for controlling by sound the transmission of electric currents and the reproduction of corresponding sounds at a distance, or, in other words, to telephones. The letters patent contained at first 30 different claiming clauses, but these have by disclaimers at different times been reduced to one only. The defence put in originally in the action merely denied the infringement of the patent, but after issue joined the defendants, by leave, put in a further defence by which they set up that the invention, the subject of the patent, was not novel or useful, that Edison was not the first inventor, that the specification was insufficient, and that the invention had been published in this country before the date of the letters patent in 21 several publications. At the trial, however, most of these points were dropped, none of the alleged cases of anticipation was relied upon or gone into, the validity of Edison's patent was not substantially challenged, and three simple issues were raised by the defendants' counsel. The final clause of the specification, as last amended, now runs as follows:—"I would observe, in conclusion, that I do not claim generally the transmission and reproduction of sound by increasing and decreasing the resistance of the circuit, nor do I claim separately any of the parts or arrangements hereinbefore described and illustrated in the accompanying drawings except as hereinafter mentioned, but I claim as my invention—first, in an instrument for transmitting electric impulses by sound, the combination with a diaphragm or tympan of electric tension regulators, substantially as hereinbefore described, for varying the resistance in a closed circuit, substantially as set forth." The claim thus being for a combination of diaphragm or tympan with electric tension regulators, as and for the purposes described, the first two points raised by the defendants are—(1) that they have not used a

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diaphragm or tympan which falls within the specification; (2) that they have not used a tension regulator which is within the specification; and that, therefore, they have not taken either of the two things the combination of which alone is claimed. If the defendants succeeded on either of these points they would be entitled to judgment, but in case of failure on both they set up a third—viz., that Edison's invention is not commercially useful, having regard especially to the tension regulator portion of it, and that there is no evidence that any such tension regulator as he describes was in actual use. I do not stop to consider in detail the various discoveries and inventions the improvements upon which are the subject of the letters patent now before me. It is sufficient to say that before the date of that patent it was known that if two similar plates or tympans capable of vibrating were placed a short distance apart and were mechanically connected the vibrations caused in one of them by speaking to it would be reproduced in the other, and this would in its turn cause pulsations in the air corresponding with those which made the first vibrate, and thereby reproduce articulate speech. It was also known that by the use of the electric current certain sounds, such as musical notes, could be transmitted to considerable distances, but no mode by which articulate speech could be reproduced at long distances had yet been worked out. The question for solution was—How can the pulsations of air caused by speech be made to operate upon a continuous electric current in such a manner that the current will reproduce vibrations or pulsations of air corresponding with those which first operated upon it? The mode in which Edison solved the question was by the use of a diaphragm to receive the pulsation of sound and operate correspondingly by causing variations of resistance in the electric current, and the arrangement by which this operation was accompanied was what he calls an "electric tension regulator." It is necessary, therefore, to consider these two things separately. But before doing this I should refer to the general description of his invention given by Mr. Edison in his letters patent. He says in his specification:—"This invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication and a corresponding sound is produced at the receiving station, so that oral communication can be sent by electricity and clearly distinguished at the receiving station. Musical tones may also be sent, but my present invention is specially available in transmitting and receiving oral communications. In transmitting musical tones the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent; but in speaking there is little change in the musical tone, but considerable change in the modulations and inflections of the voice. In my present invention I make use of the vibrations given to a diaphragm or tympan by speaking into a resonant case to produce a rise and fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound-waves produced by articulation, and an electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate. The transmitting instrument in a complete form is represented in sections in fig. 1, and fig. 2 represents a receiving instrument which may be employed with it. Referring to fig. 1, the resonant tube or box, *a*, is of a size and shape adapted to being spoken into, the same having an opening at one end or side and a diaphragm or diaphragms, *b*, against which the sound-waves from the human voice act, and these and the motion that the diaphragm receives are the means of producing the rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery, B, connected to the line, *l*, will transmit a greater or less current to the distant electro-magnet, *m*, in fig. 2, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate, *c*, and develop sound corresponding to the articulation at the transmitting station. The general features thus described pervade my entire invention, but, in developing the same, many useful and important modifications and variations have been made which I will proceed to set forth." After referring to some details which are not of importance for the present purpose, the inventor proceeds as follows:—"The next feature requiring consideration is the character of the diaphragm in the speaking instrument. Many materials have been used by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of them produce a prolonged or second vibration from their own resonant character, hence the articulation is defective and the sound vibrations blend." His Lordship read a further extract, in which the inventor states his preference for mica, and continued: He then gives certain details with reference to his tension regulator, which I pass by for the present with the observation that he then refers to a diaphragm "covered with plumbago," which differs somewhat from what he had previously described. He then proceeds as follows:—"I sometimes perforate the diaphragm 10, fig. 18, and place a strip of elastic material, 40, across the said diaphragm over the hole, and upon this a piece of foil, so that the same responds to every weak vibration, and in some cases two or more diaphragms are provided at different sides of the resonant box, each with its own tension regulator, the diaphragms being either the same or of different sizes, characters, or tensions, so as to respond to varying sounds or acoustic conditions, the various tension regulators being all in the electric circuit, line 18. This will produce greater rise and fall of tension for longer lines in consequence of the diaphragms acting simultaneously on the tension regulators." In another passage he describes a totally different arrangement for a diaphragm. "A plate supported eccentrically and free at its edges when placed in the speaking tube responds advantageously to the tones of the voice; the circuit with this plate is completed through one or more tension regulators placed round its edges." In that passage the inventor does not use the phrase "diaphragm or tympan" at all; but it is clear that he is there referring to one form of the arrangement which is elsewhere indicated by that name. From these various extracts from the specification it is obvious that Mr. Edison does not confine himself to one kind of diaphragm. It is clearly pointed out that diaphragms may vary in number, and may be one, two or more. When more than one in number they may be of the same or different sizes, characters, or tensions; they may vary in position and may be at the ends or sides or wholly or partially across the instrument, or one may be mounted upon a perforation in another. They may differ in material, though the inventor gives reasons for preferring mica, and they may be set up in different ways, for they may be strained if constructed of a membraneous material like vellum, which requires straining; or if the material, like mica, does not require to be strained, the diaphragm may either be secured at its edges, or it may be supported eccentrically with the edges free. The specification frequently refers to a diaphragm or tympan as though they were synonymous terms, and an argument is founded upon this that nothing could be a diaphragm within the meaning of Edison's specification unless it were more or less a tympan or drumhead also, and it was said that nothing of that character was found in the defendants' instruments. Mr. Conrad Cooke, in particular, made a strong point of this. But I agree entirely with the opinion of Lord Justice Fry that the diaphragm described is susceptible to vibration produced by the voice, and this is common to a tympan also; and I do not think that calling it a tympan means more than this. And even if it could be said that in some form Edison's diaphragm was not a tympan at all, I do not think it material that a thing is called by an inapt name when I find the thing itself described with sufficient fulness and clearness for all practical purposes—as is the case here. The next point is as to what is the diaphragm referred to in this specific case. The ordinary meaning of the word is a partition or separation; and in the present specification I think it clearly means something which is capable of vibrating, and which divides the air on one side of it so as to allow of differences of air pressure on the two sides which produce the necessary vibrations of the diaphragm. It is proved to be quite immaterial on which side of the diaphragm the tension regulator is placed, and therefore it is not in any way essential that the diaphragm should separate one portion of the instrument from another part of it. In point of fact, one form of instrument shown in Edison's specification has a tension regulator on the side of the diaphragm on which the speaker is. I have read from the specification Edison's description of the object of the diaphragm; and the witnesses on both sides concur in the view that its function, as indicated throughout that specification, is to receive and take up the air-waves and pulsations of sound produced by the voice and vibrate in accordance with them, and thus produce a varying or changing pressure upon the tension regulator resulting in a varying use of all in the electrical resistance of the circuit which, the specification points out, must be closed, and further that the form or shape of the instrument which thus gathers up the air-waves is immaterial except in degree. I think the evidence of the defendants' witnesses, Prof. Forbes and Mr. Conrad Cooke, when subjected to a little pressure in cross-examination, quite as clear upon these points as that of the eminent witnesses called for the plaintiffs. It is necessary now to consider the form of the instrument the defendants have made and sold. It consists of a conical hollow mouthpiece made of thin black wood, into the open, larger end of which the voice of the speaker passes. Towards the lower end of the cone the wooden part suddenly becomes larger and forms what has been distinguished as the black base. Within this is a cylindrical chamber into which the smaller end of the cone opens, and which chamber is of considerably larger diameter than such opening. To the sides of this chamber two points or blocks of hard carbon are firmly fixed, and a pencil of similar carbon with attenuated points is supported at its ends by each pair of blocks, the points resting lightly in a larger cavity in each of the supporting blocks and being in what has been called "loose contact" with them. The other end of this cylindrical chamber in the black base is then closed by its being fastened firmly to a piece of red stained wood, which is the portion of the instrument furthest from the speaker's voice, and has been called for distinction the "red back." The carbon blocks and pencils form the defendants' tension regulator, about which I shall have to say more presently, and they are connected in the usual manner with a line wire in a closed circuit, so that the electric current passes from one block to the other through the pencil which connects them. A portion of each pencil is opposite to the opening at the thinner end of the cone, and is visible through it. When the black cone is spoken into, the tension regulator is affected in such a manner that articulate speech is reproduced at the receiving end of the closed circuit, and the question is whether the means by which such result is obtained are protected by the plaintiffs' patent. It appears quite clear to me that the use of the red back is the use of a diaphragm within the meaning of that patent. The arrangement of the black cone and base, the red back, and the tension regulator are substantially the same thing as the transmitting instrument fully described in Mr. Edison's patent, except that the tension regulator is on the nearer instead of the further side of the diaphragm, which is represented in the defendants' instrument by the red back, and this variation of its position is admitted

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to be of no importance. Indeed, it is proved that when the pulsations of air caused by the voice are made to strike upon the back or outside of the red back the defendants' instrument speaks quite as well as, and under some circumstances better than, it does when the voice speaks into the mouthpiece in the ordinary way. It is true that in the defendants' instrument the diaphragm is made of wood, which is not mentioned by Mr. Edison as one of his materials, and the use of which substance as a diaphragm is said to have some disadvantages. But a patent cannot be infringed with impunity by the adoption of an inferior material for a given purpose in lieu of a more efficacious article indicated by the patent for the same purpose, and it is obvious from the use of other instruments, and from the defendants' own instrument, that wood will answer very well for the purpose of a diaphragm. It is not necessary for me, for the purposes of my judgment, to say more than that by the use of the instrument of which the red back forms a part the defendants have used a diaphragm within the meaning of the plaintiffs' patent. But it has been clearly proved that if the red back is taken away the rest of the defendants' instrument still operates as a good telephonic transmitter; and the question whether any combination in which the black wooden portion of the instrument, consisting of the conical mouthpiece with its back base, or either of those parts, is included is protected or not has also been fully argued, and as I have considered it carefully and have formed a clear opinion upon it, and it may be important to the parties to know what my opinion is, with a view to subsequent action, I proceed to deal with it. I entertain no doubt that the use of the black part of the defendants' instrument, as well as the red back, is the use of a diaphragm within the meaning of Edison's specification. Each of those parts separates the air on one side of it from the air on its other side, and thus allows the differences of air pressure to exist on its opposite sides which render it susceptible of vibration, when the air-waves come in contact with it, and it gathers and takes up these sounds and vibrates in accordance with them and transmits them to a tension regulator. The experiments tried by Dr. Hopkinson, the details and results of which were fully explained by him, and were not challenged by the defendants, prove this to demonstration. The trials of the several portions of the defendants' instrument as parts of a telephone which acts solely by mechanical vibration were completely successful, and the instrument spoke perfectly. The defendants' counsel attempted to make out that the operation of the defendants' instrument was produced solely by the direct impact of the sound-waves upon the pencils of carbon in the defendants' tension regulator, and that the vibration of the black cone and base and the red back had nothing to do with it. But this is quite inconsistent with the result of the experiments and also with the proved facts that the defendants' instrument speaks better when the outside of the red back is addressed than when the voice enters the mouthpiece, and that it speaks quite as well when the aperture from the narrow end of the cone into the cylindrical chamber is closed by a cork; when the cone is continued down to the red back, as in J. H. 2; when the pencils are moved further apart in the cylindrical chamber, so as to be sheltered from the direct action of the voice, as in J. H. 3; and when the outside of the black cone is spoken to, as in its normal condition. In fact there is no real conflict of evidence upon the question whether these portions of the defendants' instrument performed the functions of the diaphragm as such functions are described in the plaintiffs' specification. The defendants' witnesses, when pressed in cross-examination, confirm the direct evidence of the plaintiffs' witnesses. The defendant Bassano says that these portions of his instrument are really for a totally different purpose; that the function, or main function, of the black cone is to concentrate the air-waves from the voice on the tension regulator; that the black base is to hold the carbon-blocks which support the pencils, and that the red back is merely a support for the rest of the arrangement. But even if this be so, yet if they discharge the function of the plaintiffs' diaphragm they are none the less an infringement. But the most important contention on the part of the defendants is that even if the above-mentioned parts of their instruments so perform the functions described still they do not come within Edison's specification. In other words, they attempt to circumscribe the area of that specification and limit it to particular kinds of diaphragm and tension regulators as much as possible. This is clearly shown in the answers of the defendant Bassano to his counsel's question whether he considered the black cone or base, or the red back, to be diaphragms, to which he replied, not by a simple negative, but by saying he did not consider them diaphragms according to the specification of Edison, and the other witnesses for the defence take the same line. So, too, the defendants' counsel press upon us that Edison's diaphragm is a distinct portion of his instrument figured in his illustrations, distinguished by a letter, and shown in particular positions, and also further identified as being made of mica as the material preferred, and being in every one of these points something quite different from the parts used by the defendants which are said to be infringements. But I have already pointed out that the specification is not confined to one special form of diaphragm. On the contrary, it describes diaphragms differing in size, number, material, form, position, and otherwise, though the common function they are to perform is clearly shown. Under these circumstances it is impossible for me to hold that the patentee is limited to any special form. Indeed his claim is the combination of a tension regulator with "a diaphragm or tympan," not confining it to any special form, and I have heard no complaint that the claim is too large in this respect. The contention of the defendants appears to me incapable of being maintained, either upon principle or authority. As regards principle the patentee discovered a very remarkable new manufacture, and described its essential conditions, and pointed out how it was to be performed, and indicated several practical modes of carrying it into effect, and the law does not require him to describe every way of carrying it out, or limit the protection it confers to the modes particularly described. If the defendants place a diaphragm in their apparatus which performs the functions of the diaphragm in the plaintiffs' apparatus, they cannot escape the charge of infringement by making a non-essential variation in the position or form of the diaphragm material. And, as regards authority, the decision of Lord Justice Fry in the case he decided seems to me to cover the present case. In the specification and drawings of the plaintiffs' patent the diaphragm is always referred to by the letter *b*, and this is made to operate by its vibration on an electric tension regulator in physical, but not necessarily in mechanical, connection with it. The regulator first described is of compressible bunches or tufts of elastic fibre, forming part of the circuit connected either by a diaphragm, spring, or secured by solder, or by a delicate cork centre piece, or with a piece of platinum foil, *x*, in contact with the fibre; in all instances the telegraphic circuit being made by a thin strip of platinum or similar material extending to the centre from the line or battery connection. In that case it is quite clear that the piece of platinum foil is not described as part of the diaphragm nor exposed to the air waves, though no doubt it is affected by the vibrations of the diaphragm through the cork or the spring; but is described as part of the tension regulator, and actually forms an essential part of the electric circuit. The alleged infringement before the Court on that occasion was Hunning's transmitter. In that the diaphragm, *b*, had been taken away altogether and the platinum foil, *x*, was left exposed to and received the sound waves, and it was held by Lord Justice Fry that the platinum foil, though described as a separate independent portion of the instrument and as part of the tension regulator and not of the diaphragm, was in fact a diaphragm, which, being combined with the tension regulator as described in the specification, was within the scope of Edison's invention and was an infringement. It was argued in that case, as here, that the absence from the defendant's instrument of a diaphragm corresponding with *b* saved that instrument from being an infringement; but the argument failed, and the decision in that case is an authority—if authority be necessary—which applies to the present case and disposes of that argument. It was also said by the defendants that their instrument does not require anything in the nature of a diaphragm; that it will act perfectly without, and therefore that it cannot be an infringement of Edison's combination. And they appeal to the experiments made with carbon blocks and pencils. Those made by the defendants' witnesses were successful to some extent; those by Sir William Thomson did not answer so as to produce articulate speech. It is obvious that there is still room for further investigation in this direction, but the question whether the defendants could dispense with a diaphragm or not is not now before me for decision. As a matter of fact they never have done so, for they have never used thin carbon blocks and pencils in practice except in combination with the cone, the black base, and the red back, each of which, as the defendants' witnesses admit, does assist, by intercepting the sound waves vibrating synchronously with them, and so acting on the tension regulator, and they have therefore adopted Edison's combination unless the tension regulator they have used is outside his specification, the point I now proceed to consider. The electric tension regulator of the Edison specification is the apparatus forming a joint or link in a closed circuit, by which the vibrations of the diaphragm are made to produce a rise and fall in the electric current passing along the line wire by varying the amount of resistance, such variation being caused by increasing or diminishing, by the change of pressure, the area of surface contact within the regulator. In a passage in the specification which I have already read, Edison says that the motion of the diaphragm is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth. He also says, "I find it is not practicable to open and close the line circuit in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small bunches and tufts or discs of semi-conducting fibre, such as particles of silk, and an intermediate conducting or semi-conducting material; this device I call an electric tension regulator; it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed, or lessens as the fibre expands." At page 7, line 15, he describes an arrangement shown in fig. 10, in which the diaphragm is placed at the end of a resonant chamber, and has at each side of it springs with points made of compressed plumbago, mixed preferably with gum or any substance not liable to rapid decomposition, or the "elastic or fibrous tension regulator aforesaid may be used." And after pointing out how this operates to vary the current by creating greater pressure upon the plumbago points on the two sides alternately, he says that, as the tension regulator of fibre or plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. A little further on he speaks of another arrangement by which a plumbago contact point is so arranged as to present a semi-rigid point for contact, so as to pre-

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vent a rebound and allow of a slight yield when the plumbago is pressed by the diaphragm. Without attempting to go through all the various forms of tension regulator mentioned in the specification, in some of which carbon is not used at all, I refer to page 10, line 3, where the patentee says: "In preparing the tension regulator I find in some cases that it is preferable to use lamp black mixed with pure plumbago, amorphous phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate." It appears clear to me, as it did to Lord Justice Fry and Lord M'Laren, that Mr. Edison did not attempt to describe every form of tension regulator to be used with instruments made under his specification; but Lord Justice Fry pointed out that the regulators he describes have three essential properties—(1) that of compressibility, in order that the area of surface contact may be capable of being increased by pressure, and the resistance to the current diminished accordingly; (2) that of resiliency, either from the natural elasticity of the substance employed or produced by artificial means, so that when the pressure is removed the material may return to its normal position, and thus check the current, which had been increased by its compression, and be in a position to repeat the operation time after time; and (3) that of semi-conductibility. In the present case the scientific witnesses on both sides agree that these three qualities must be found in Edison's tension regulator. The question then is whether the hard pencil carbon used by the defendants in their instrument, as I have explained, comes within the description of "electric tension regulators substantially as hereinbefore described," as used in Edison's specification. The plaintiffs' witnesses say that it does, for that it is semi-conductive, compressible, and resilient. The defendants' witnesses say that it does not, for it is not semi-conductive, not compressible, and therefore not resilient. And yet, when the evidence is considered attentively, there is very little, if any, difference between them after all. It is merely a question of degree. For instance, it is said by Mr. Conrad Cooke that hard carbon is not appreciably compressible, and no doubt it may be said that in comparison with the tufts of fibre described by Edison a piece of hard carbon, or a billiard ball, is not compressible. But if dropped from a sufficient height upon a hard, flat surface a billiard ball is compressed to half its diameter; and the carbon pencils of the defendant are compressible in the same way. In fact, Mr. Bassano himself says that hard carbon must be to some extent compressible in virtue of its elasticity, the same as a billiard ball is elastic, and Mr. Cooke says that when the defendant's carbon pencils are made to a point they are exceedingly compressible at that point; and the evidence is clear that even the slight motion caused by the effect of the voice in the defendant's instrument suffices to produce such a movement of the pencils in relation to the carbon blocks that by reason of the inertia of the pencil, a squeeze or compression is produced in the substance thereof to such an extent that the area of surface contact is appreciably affected thereby, and that it is by means of the variations thus obtained that the defendant's instrument is made to reproduce articulate speech. Again, it is said that hard carbon is not semi-conductive because it is a good conductor. But this also is a question of degree. Mr. Conrad Cooke says that hard carbon may be called a partial conductor—it is a pure question of comparison—that comparing it with the line wire of copper it might be called a semi or partial conductor, or even a bad conductor, certainly an imperfect conductor, and that for Edison to call carbon a semi-conductor is a fair expression having regard to the circuit in which it is placed, and the defendant Bassano agrees with this. But it is also said, even if the defendants' hard carbon blocks and pencils have the attributes of Edison's tension regulator, a regulator of hard carbon is still quite a different thing from any described in that specification. To this there are many answers. In the first place I have already pointed out that Edison's specification does not limit him to specific forms, or to plumbago, or even carbon only. In the next place Edison does specifically describe a form of tension regulator with points of compressed plumbago, which is one form of carbon, and Mr. Imray's evidence is clear that there is no difference in operation between the plumbago point there described and the carbon used in the Blake, the Ader, the Gower-Bell, the Theiler instruments, and in the defendants' instruments. Further than this, I consider the decisions of Lord Justice Fry and Lord Maclaren both dispose of the contentions of the defendant upon this point. In the Scotch case it was held that Theiler's instrument was an infringement of Edison's, and in that the tension regulator consisted of pencils of hard carbon exactly similar to the defendants', the effect being produced by the inertia of one weighted pencil suspended across and pressing lightly against two other pencils of the same substance, to which the vibrations of air were communicated by a diaphragm; and in the case tried by Lord Justice Fry, the tension regulator in the infringing instrument was made with small pieces of coke, which, as the learned Judge pointed out, is only hard carbon in a somewhat different form. Before passing away from this part of the case, I desire to refer to the very straightforward evidence given by the defendant Bassano in cross-examination. He says: "In the defendants' instrument the sound waves are taken up to some extent by every part of it, the mouth-piece, the black base, and the red back, whether you speak into it or to the outside. The vibrations of those parts are communicated to carbon blocks fixed to them, and the blocks and the pencils resting on them have motion relatively to one another. The result is a change of position in the carbon surfaces in contact, accompanied by some pressure. This, to the extent of the compressibility of the carbon, varies the area of the carbon surfaces in contact; this varies the resistance of the electric current synchronously with the vibrations caused by the sound waves, and the circuit being a closed one, the result is that the sound waves created by the voice at the transmitting end are reproduced at the receiving end to the person listening." This is a very fair description of the defendants' instrument and its mode of operation, and I am of opinion that it is like Edison's combination of a diaphragm or diaphragms vibrated by the voice with an electric tension regulator consisting of a semi-conductive, compressible, and resilient substance for varying the resistance to the electric current in a closed circuit, and that it is within the scope of, and an infringement of, Edison's specification. The third point raised may be very shortly disposed of. It is that Edison's invention, especially the tension regulator portion thereof, is not commercially useful, and has never been in actual use. If this be so, it does not follow necessarily that the patent is bad. Lord M'Laren disposed of that argument by saying, "It does not appear that any of the mechanical combinations described in the specification ever came into commercial use, probably because, as may happen in the history of even the most original and valuable inventions, these were immediately superseded by simple constructions involving the same principle." But in the present case there is direct evidence on the subject. Sir Wm. Thomson proves that he has seen transmitters constructed in some of the forms Edison described in actual use, and has himself used them for years; and that all the forms of tension regulator specifically described by Edison are practically useful, and any one of them could be used as a commercial instrument. Prof. Forbes says that looking at the specification and figures, the mode in which Edison intended the tension regulator to act is as clear as possible; and from a scientific point of view theoretically would act. He could not say if they would act practically or not, as he had not tried them; his impression was that most of them would require large power. Again Mr. Conrad Cooke says that Edison's tension regulator would not act if the diaphragm was taken away, and it was obviously his view that if it was not taken away they would act. Moreover, none of the plaintiffs' witnesses were cross-examined for the purpose of showing that any of Edison's tension regulators would not act. On this point also, therefore, the defendants fail.

LEGAL.

Crossley Brothers, Limited v. Littleton.—In the Lord Mayor's Court on Friday, Messrs. Crossley Brothers, the makers of the Otto gas engine, sued Mr. Littleton for payment of £12 6s. 3d., which they alleged to be due for repairs to a gas engine. The defence was that the repairs were such as were covered by the terms of the six months' guarantee given by Messrs. Crossley upon the sale of the engine. In reply to this, plaintiffs contended that they never sold the engine to Mr. Littleton, but to a Mr. Heath, who re-sold it to the defendant. The evidence for the plaintiffs was that they received at their offices in the Poultry an intimation from Mr. Littleton that the gas engine which he had purchased was not working satisfactorily, and they offered to send a man to see what was necessary to be done. A workman, Goodacre, who was called as a witness, went to the defendant's residence in December, 1884, and altered a catch, after which, he said, the engine worked all right. By direction of Mr. Lupton, Messrs. Crossley's representative in London, he subsequently paid further visits, and effected certain repairs. These repairs were not, he said, such as came within the guarantee; they were probably necessitated by the engine being shaken when conveyed from the Health Exhibition to Mr. Littleton's residence at Sydenham. Mr. Lupton's evidence was to the effect that Mr. Littleton called upon him and made enquiries respecting a gas engine, when he offered him one which was then in the Health Exhibition. Defendant thought this would suit him, and then said he should want the trade discount of 15 per cent. This, witness said, he could not allow, as it would cause unpleasantness with the trade; he offered him, however, a lesser rate of discount. Mr. Littleton insisted on the trade terms, and witness said he could not meet him in that way, but he might get the engine through the trade, and thus secure a larger abatement. He suggested to him the name of a man in the trade, and the defendant went away. The engine was bought by Mr. Heath, and after the latter had re-sold it to Mr. Littleton, an intimation was received that the engine was not running properly. Goodacre was sent down, and after several visits the engine was got to work. Cross-examined by Mr. Corrie Grant, defendant's counsel, witness denied having said that he would send their engineer to arrange terms with Mr. Littleton; he suggested "a man in the trade," and mentioned Mr. Heath's name, but not as their engineer or agent. During cross-examination he first said he would swear Mr. Littleton never came to him to complain of the delay in fixing the engine; had he done so he should have referred him to Mr. Heath, as the matter had nothing to do with Crossley's then; subsequently, however, he admitted that Mr. Littleton might have so called. Mr. Heath, examined by Mr. Haigh, counsel for plaintiffs, said he was a contractor, and was not Messrs. Crossley's engineer, nor was he a servant of theirs in any capacity. In November, 1884, he purchased from

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that firm a gas engine, and signed a contract with them. Previously to that he had had an interview with Mr. Littleton, to whom he had agreed to sell the gas engine, at a discount of 10 per cent. from the published price, and 2½ per cent. for cash down. The contract between them was put in writing at his (Mr. Heath's) request. Mr. Littleton paid him for the engine and he fixed it. He received no commission from Messrs. Crossley, but merely purchased from them on the ordinary trade terms. Cross-examined, he said he was at Crossley's on another matter when Mr. Lupton told him there was an order he might get. He went to Mr. Littleton's and told him he had heard he wanted an engine, and was prepared to sell him one. He had not bought the engine then; he did not buy a thing until he had some chance of selling it. This concluded the evidence for the plaintiff. Mr. Littleton said that at the end of 1884 he was fixing the electric light at Westwood House, Sydenham, and wanted a gas engine. He went to Messrs. Crossley's, in Poultry, and told them of his requirements. Plaintiff's representative, Mr. Lupton, told him that they had an engine at the exhibition which would probably suit him, and which could be delivered without delay. Witness claimed the trade discount, for although he was not in the trade he was closely connected with it. Mr. Lupton said he could not think of allowing the trade discount of 15 per cent., but offered him a small reduction, as he was afraid it might offend some of their trade customers to give him the full discount. Witness said he could get a friend to purchase for him at the trade price and hand it over to him for the same price only which he had given for it. As witness was leaving the shop, Mr. Lupton said, "We might as well deal direct, as place the order through a third person," and suggested that they should send him "their engineer." Witness replied that it was immaterial to him how the order was placed. Mr. Lupton said the utmost he could give him was 12½ per cent.; witness accepted that offer and left him upon the understanding that he would send him someone. Mr. Heath came and said he was informed by Messrs. Crossley that he was in want of a gas-engine. Witness said that was true, and Mr. Heath added that the plaintiffs had sent him to take the order for it. Heath offered him 10 per cent., but witness told him he must be under a mistake, for they had already arranged terms, and he was to have 12½ per cent. They eventually agreed to the latter terms, and the engine was sent, witness signing a contract with Heath. A trial run was made about the end of the year, and the result was unsatisfactory. Witness reported the matter to Mr. Lupton, at the Poultry office. Mr. Lupton said they must send someone down to see what was the matter. Goodacre came and rectified the slight derangement which existed; other repairs became necessary; for one thing, the water in the water jacket escaped through the joints into the cylinder. These repairs were done by plaintiffs' workmen. One or two small claims were sent to him at the beginning of the year, but he did not think those claims were seriously made. In June or July last he received a letter asking why the account was not paid. This account was simply to goods delivered, and he thought it had reference to other matters. He called on them and said he did not consider they had any claim against him. He did not see all the accounts; probably the letters had miscarried in the process of delivery. He thought all along that it was with Crossleys he had been dealing, and it was not until now that Mr. Heath was named. There had been some discussion respecting dealing direct, and finally the terms mentioned were agreed upon. Mr. Lupton, recalled, positively denied having said to Mr. Littleton that he would send "our engineer," to take the order from him. He did not in any way promise him, either, that he should have an engine at 12½ per cent. discount. In further cross-examination, he said it may have happened that when Mr. Littleton was going away without having concluded the bargain he called him back; he wanted to get all the orders possible, and rather than lose this chance he called him back and tried to get into further conversation with him. No doubt he mentioned Mr. Heath's name in suggesting that Mr. Littleton might get the engine through the trade. He was quite positive nothing was said about the guarantee after Mr. Littleton came back. Mr. Corrie Grant, in addressing the jury submitted that the point at issue was purely a question of fact, and they would have to decide which of the two stories they would believe. With regard to the guarantee, his contention was that it covered the repairs, payment for which was sued for. Goodacre no doubt spoke from his own experience in saying that the work was not within the terms of the guarantee; he, perhaps, had never done just the same kind of repairs under the guarantee, and therefore stated what he did in evidence. His Honour, interrupting Mr. Grant, said he was afraid he could not tell the jury to find that. The witness stated that the work done was not under the guarantee, he was not cross-examined upon the point, and his statement remained undisputed. How could the jury find a verdict directly against that uncontradicted evidence? A slight discussion between counsel and judge ensued, after which Mr. Grant resumed his address, and submitted to the jury that the substantial question was as to which story was the correct one—that of the plaintiffs who repudiated Mr. Heath as being their agent, or to the defendant, who stated that Heath was sent to him, under arrangement with the plaintiffs, to act for them. If they would declare in favour of his client upon that point, he would be contented. Mr. Haigh having addressed the jury for the plaintiff, the judge, in his summing up, said the first question was, was the work done within the guarantee? He might express an opinion upon the subject, and his opinion was that where the evidence stated that it was not, and that evidence had not been questioned in any way, it was for the jury to give due weight to the fact that the question was not really disputed. But if, notwithstanding this, they thought it was within the guarantee, then the point for their consideration was whether the defendant purchased the engine from Messrs. Crossley or from Mr. Heath. Having reviewed the evidence, His Lordship said, in conclusion, that the defendant said Heath represented himself as coming from the plaintiffs'; but the contract put in was, singularly enough, made out in Mr. Heath's name, and Messrs. Crossley were not mentioned in it. After a brief consultation, the jury found a verdict for the plaintiff.

THE DIFFICULTIES OF SHIP LIGHTING.

MESSRS. R. E. CROMPTON & CO. have been entrusted with the order for wiring the two new gunboats, now being rapidly completed at the Devonport Dockyard—namely, H.M. ships *Landrail* and *Curlew*. The work was given to Messrs. Crompton on their undertaking to complete one boat, the *Curlew*, in six weeks. As each ship is only to be fitted with about 85 incandescent lamps and search lights, this would appear an easy matter to any one not well acquainted with the difficulties involved. The contract, as is now usual with such work for the Admiralty, includes supplying, fixing and fitting all teak casings for the wire leads, and drilling all holes, piercing decks, &c., also fixing all fittings, switches, cut-outs, &c. It is of course well known that on all fighting ships of recent design space of any sort is of the utmost importance, but such a generalisation as this conveys an utterly inadequate impression to the minds of the uninitiated as to the difficulties to be overcome by the electrical contractor in such cases as the *Landrail* and *Curlew*. It is no exaggeration to say that every available space is already occupied either with steam pipes, water pipes, ventilating pipes, speaking tubes, gun-firing circuits, bells, signals and gear of every description, and owing to the existing fittings and the rigorous rules as to piercing watertight bulkheads, it is frequently necessary, in order to carry the wires through a space, sometimes not exceeding a few inches, to turn them upwards through one or more decks, sometimes of steel, until a suitable place is found, and then descending sometimes through the same decks, the wires are at last placed in the necessary position, and an uninterrupted run of a foot or two may be gained before the next difficulty has to be overcome. When it is further borne in mind that in the majority of positions in which the wires are fixed, it is quite impossible for even a small man to stand upright, and that in some specially cramped places even sitting down between decks is a tight fit, it may fairly be concluded that the contractors have no easy task to perform, and that the electrical engineer's lot under these conditions is not too happy, and were it not for the able assistance and advice generally courteously given by the dockyard officials, it would, under these circumstances be next to impossible for contractors to take up such work.

REVIEW.

Electricity Treated Experimentally.—For the use of schools and students. By LINNÆUS CUMMING, M.A., Assistant Master in Rugby School. Rivingtons: Waterloo Place, London.

For the purpose of directing a teacher in a course of lectures, this book is, we think, admirably adapted. There are plenty of very clear illustrations of experiments and apparatus and sufficient, but not too much, letterpress. A number of excellent examination questions with answers to the same are given at the end of the several books into which the volume is divided. We notice a few practical mistakes which, however, are excusable, the author's experience being,

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we imagine, entirely in the domain of theory; thus, for example, it is stated that the zinc coating on telegraph wires is laid on by electrolysis, a supposition which may have arisen from the absurd name "galvanising" which has been given to the actual process. On the page relating to telegraph apparatus, also, it is stated that "there is usually an electric bell at each station to call the attention of the clerk when a message is to be sent"; it is, perhaps, almost unnecessary to say that the use of bells has been abandoned for more than 30 years, the "click" of the instrument being all the alarum that is required in practice.

NOTES.

Viscount Bury's Electric Lighting Act Amendment Bill—This Bill, which was introduced in the House of Lords last week, is a short one, and provides for the purchase of an undertaking after 42 years. The main clause of the Bill is as follows:—Section 27 of the principal Act is hereby repealed, and in lieu thereof the following provisions shall have effect, that is to say, "Where any undertakers are authorised by a Provisional Order or special Act to supply electricity within any area, any local authority within whose jurisdiction such area or any part thereof is situated may, within six months after the expiration of a period of 41 years from the date of the passing of the Act confirming such provisional order, or of such special Act, and within six months after the expiration of every subsequent period of seven years, by notice in writing require such undertakers to sell, and thereupon such undertakers shall sell to them their undertaking, or so much of the same as is within such jurisdiction, upon terms of paying the then value thereof as a going concern. Such value in case of difference shall be determined by arbitration, and due regard shall be had to the nature and then condition of the buildings, works, materials, and plant of the undertakers, and to the state of repair thereof, and the suitability of the same to the purposes of the undertaking, and where a part only of the undertaking is purchased, to any loss occasioned by severance. The Board of Trade may determine any other questions which may arise in relation to such purchase, and may fix the date from which such purchase is to take effect, and from and after the date so fixed, or such other date as may be agreed upon between the parties, all lands, buildings, works, materials, and plant so purchased as aforesaid shall vest in the local authority which has made the purchase, freed from any debts, mortgages, or similar obligations of such undertakers, or attaching to the undertaking, and the powers of such undertakers in relation to the supply of electricity under this Act or such provisional order or special Act as aforesaid, within such area or part thereof as aforesaid, shall absolutely cease and determine, and shall vest in the local authority aforesaid."

The Electric Light at the Law Courts.—The following is not at all a pleasant story of what sometimes happens at the Law Courts; a want of proper management, one would think, is the cause of the calamitous state of things referred to. A daily paper one day this week said:—"On Saturday the dangerous character of the mode adopted at the Royal Courts of Justice of fixing the pear-shaped vacuum glasses enclosing the incandescent electric lights was brought to the notice of the Vice-Chancellor, Sir James Bacon. Occasionally one of the glasses, all of which taper at the bottom to a sharp point, falls to the ground without the least warning, and it is generally smashed to atoms, to the no small consternation of those who happen to be near. On Saturday morning two of them fell in the Vice-Chancellor's court, one of them alighting on the wig of a learned counsel and the other on the unprotected head of a shorthand writer. The Vice-Chancellor therefore sent for the electrical engineer, and on his attending informed him of what had taken place. His lordship, after hearing an explanation, said he thought that the engineer's own statement showed he was to blame, and if any mischief was done it would be laid at his door. The matter required immediate attention, and the occurrence ought not to happen again. Before leaving, the engineer, at the Vice-Chancellor's request, examined most of the vacuum glasses in court, and removed no less than five, which he found to be loose."

Electric Light on a Pleasure Yacht.—The well-known cutter yacht, *Kremhilda*, Mr. A. C. Boothby, which is about to proceed on a cruise to the Mediterranean, has been recently fitted by Messrs. Siemens Brothers with the electric light, this work having been carried out on a most extensive scale. A Brotherhood's engine combined with a dynamo is fitted on deck for the purpose of generating the electricity for charging accumulators. The engine is driven from the boiler of a steam launch, which the yacht will carry, and two hours' running of the dynamo will generate and store sufficient electricity for a week's lighting.

Maxim-Weston Electric Company, Limited.—We are informed that this company has just completed the lighting of the extensive new flour mills at Newcastle, the property of Messrs. Robert Hedley & Co. The following is their account of the installation:—"Our lights are all 20 C.P. lights, which are suspended from the joists some 10 to 15 inches, and usually are so placed in clear positions as to light a space equal to 15 feet by 15 feet. On the roller floor the lamps are numerous, a good light being required in this department, and are placed in a line as far as possible and between the different lines of roller mills, and thus securing a full diffusion of the light. The distance apart varies from 10 to 16 feet according to the placing of the machine. On the centrifugal and reel floors they are placed between every two machines, admission being thus obtained from one side or the other to all machines, whilst the portable hand lamps supplied to us by your company, according to specification, enable an examination to be made into the interior of any machine with safety. In warehouses one 20 C.P. lamp to a space of 15 feet by 30 feet will be found sufficient. Generally the light keeps the interior of the mill cool. We adopted the light after a careful calculation of comparative cost of gas and electricity."

Mr. Preece and Domestic Electric Lighting.—A gas journal has been making merry at Mr. Preece's expense, delivering itself as follows:—"Mr. Preece, the high priest of domestic electric lighting, met a large audience at the Society of Arts rooms, on Wednesday night, and succeeded in keeping that audience in wonderfully good humour for the space of an hour and a half with the expenditure, on his part, of a few vague generalities, dispensed in half humorous, half cynical manner. Although Mr. Preece abstained from saying anything about his daughter's dolls house, he provided charming substitutes in the shape of a cigarette-lighter and an arrangement of electric lamp to enable ladies to do up their back hair. These advances in the science of domestic lighting will, no doubt, be admitted by all to be sufficient evidence of Mr. Preece's originality. The paper is amusing if not instructive, for the only definite feature in it is that the lighting of Mr. Preece's house now costs just double what it did when he used gas, even although he had to pay 4s. 9d. per thousand cubic feet for the gas. But the benefit to health! Who can estimate it? Mr. Preece has quite made up his mind that by adopting the electric light he has made an appreciable addition to the allotted span."

Railway Stations as Telephone Exchanges.—The United Telephone Company has made arrangements, according to one of its officials, with three of the great railway companies, to turn all the stations of the latter into telephone exchanges.

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Opening of a Telephone Exchange at Bournemouth.—The formal opening of the newly-established telephone exchange at Bournemouth took place a few days since at the local headquarters, and in the course of the proceedings Mr. H. F. Lewis, general manager of the Western Counties and South Wales Telephone Company, stated that they had at the present 41 exchange orders and four private line orders. With regard to Poole, he had hoped that they would have been able to have opened that day, but the prolongation of negociations respecting existing wires had rendered this impossible. By the middle of April, however, he trusted that the exchange between Poole and Bournemouth would be open. Later on, if it could be profitably worked, there might be connections with Portsmouth, Weymouth, and other places, but of course this would be for the future, as it would involve an expensive outlay. He pointed out that at Bournemouth they had the most favourable rate that was charged in the United Kingdom. With regard to all night communication, he promised that as soon as they reached 150 subscribers it should be conceded to them free of cost. On Sundays the exchange would be opened until nine o'clock in the morning. Mr. J. Druitt then opened the exchange, which was tested and pronounced to be thoroughly satisfactory. A discussion subsequently took place, in the course of which it was promised that as soon as 100 subscribers were obtained the exchange should remain open until 11 o'clock at night. The company afterwards adjourned to the switch room where the working of the exchange was explained to them and a vote of thanks was accorded Mr. Lewis for the invitation.

The ss. "Buccaneer."—We learn that the ss. *Buccaneer*, which has been employed in making an exhaustive survey of the soundings along the West Coast of Africa, is expected in England very shortly. In carrying out her work, which is preparatory to the laying of the cables manufactured by the Silvertown Company, this steamer has gone as far as St. Paul de Loando, and has, we hear, gathered most interesting and useful information during her voyage.

Personal.—We are informed that Mr. J. S. Raworth, formerly agent to Messrs. Siemens Bros. & Co., has been appointed Superintending Engineer to the Anglo-American Brush Electric Light Corporation, Limited.

Society of Telegraph-Engineers and Electricians.—The next meeting at 25, Great George Street, S.W., will take place on Thursday, April 8th, 1886, at 8 p.m., when the discussion on "Electric Lighting by means of Low Resistance Glow Lamps," by Alexander Bernstein, will be continued.

At the last meeting of this society the secretary announced that on the 8th, 13th and 15th of April the Lumleian lectures at the Royal College of Physicians, Pall Mall, would be delivered by Dr. Stone, the subject being "Man as a Conductor and Electrolyte," and that members of the society could, on application to the secretary of the latter, obtain free tickets for the course.

Inclines on Tramlines.—We do not consider it an easy task to set an electrically-propelled car to start with its full complement of passengers up an incline of 1 in 17, and we should be glad to know whether such a condition is ever met with in actual practical operations with either horse or steam traction. Are cars ever allowed to stop at such points as would involve the above condition?

Electric Light and Telephone Wires.—We have had brought to our notice some specimens of electric light leads and telephone cables recently brought out by Mr. W. T. Glover. We are of the opinion that there will be some demand for these new conductors, which are specially devised for purposes which Mr. Glover will doubtless explain to any applicant.

Electricity as a Motive Power.—The North Metropolitan Tramways Company notifies its intention of applying to Parliament in the present session, by petition, for leave to insert in its No. 1 Bill, now pending in the House of Commons, a clause or clauses authorising the company to use electricity as a power for moving carriages on portions of the existing or authorised tramways in West Ham, East Ham, and Leyton.

The Electric Locomotive and Power Company informs us that it has two engines finished and six others building for the North Metropolitan Tramways Company's traffic. The company has also at Stratford charging plant consisting of a 25 H.P. Marshall's engine and two Phœnix dynamos, each of 180 volts and 160 ampères—ample power for keeping charged six engines for 15 hours per day. At the factory at Homerton between 70 and 80 hands are employed principally in constructing a new accumulator (the invention of Mr. Elieson) for the engines. The board of directors has been strengthened, the Earl of Galloway being now the chairman, and all (save Mr. Elieson) have subscribed for £2,000 of shares.

The Glasgow Athenæum New Buildings.—The committee contemplate the adoption of the electric light throughout these buildings.

Sporting Query.—A sporting friend asks us for information respecting the Moseley Harriers. We can only reply that we believe the club is composed solely of members on the staff of a new Manchester periodical, but we cannot guarantee that this is correct.

The Blackpool Electric Tramcars.—We are informed that a number of cars are now regularly in operation and that Mr. Holroyd Smith's system is considered eminently satisfactory. We are pleased to learn this, and hope soon to hear that Mr. Smith is pushing his way in other directions. The time is not far distant when electrical propulsion on short lines will become a great industry.

Crossley v. Littleton.—Many of our readers will peruse with an unsual degree of interest the report of this action which appears in our other columns. Mr. Littleton has at various times contributed to our correspondence columns and his electric lighting installation at Sydenham has already been described by us. We have somewhat freely commented upon this case in the interests of domestic electric lighting generally, and we hope that Mr. Littleton's experience is an exceptional one. The following is the guarantee given by Messrs. Crossley with their engines:—"We undertake to repair or replace any parts of these engines which may be broken or suffer from undue wear within six months after date of delivery, unless such wear or breakage is caused by careless or improper treatment."

The Paddington Installation.—Is there any truth in the rumour that the electric lighting undertaking at Paddington Station is about to be abandoned? We are only too much afraid that the only answer will be, "'Tis true, 'tis true, 'tis pity; pity 'tis, 'tis true!"

The Diaphragm and Tension Regulator.—If we take an early form of Bell telephone with an electro-magnet in place of a permanent one, the diaphragm of the apparatus regulates the current. Could not this in legal phraseology be declared a combination of a diaphragm and a tension regulator? If so, Edison's specification is antedated.

Correspondent's Address Wanted.—If Mr. R. Mitchell will send us his address we will forward to him a set of circulars respecting the Khotinsky battery, left with us for the purpose. A letter directed to Mr. Mitchell at Walham Green, S.W., has been returned as insufficiently addressed.

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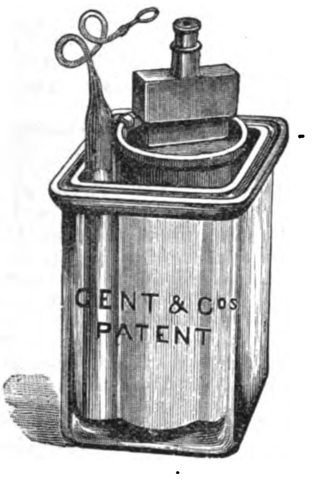
The Edison Telephone Transmitter.—In the judgment delivered in the case of the U. T. Company *v.* Bassano, Mr. Justice North says :—"It was also known that by the use of the electric current certain sounds, such as musical notes, could be transmitted to considerable distances, *but no mode by which articulate speech could be reproduced at long distances had yet been worked out.*" The italics are our own. Quoting from Mr. Edison's specification the learned judge proceeded :—"This invention relates to *that class of electrical instruments* in which sound becomes one of the elements in the transmission of the communication and a corresponding sound is produced at the receiving station, so that *oral communication can be sent by electricity*, and clearly distinguished at the receiving station." The italics are again our own. Does not this show, Mr. Justice North to the contrary notwithstanding, that Mr. Edison was aware that articulate speech had been reproduced, or why should he be careful to speak of his invention as belonging to *that class* of electrical instruments, &c. ? What says "the man who laughs" to this plum ?

Improved Battery Cells.—The illustration represents one of the patent insulated Leclanché cells of Messrs. Gent and Co., to which we alluded last week. As may be seen, the projecting edge of the glass jar is formed with a gutter or groove, in which is placed an insulating material very much resembling vaseline. The



lead tops to the carbons, which are usually found in other forms, are, as we have previously stated, done away with, the terminal being embedded in the carbon itself. We have some recollection of a similar form of glass jar having been used by Mr. Sellon for secondary batteries.

The Tours Central Station Installation.—The secretary of the National Company for the Distribution of Electricity by Secondary Generators has written stating that we did not intimate that the electric lighting installation at Tours which we described last week was carried out on the Gaulard and Gibbs system, the patents for which the company named holds. A more careful perusal of our article will doubtless reveal the fact to Mr. Pickering that he was mistaken.

Electrical Con.—Why should an electrical tramcar worked by secondary cells be the most economical ? Because it dispenses with the usual conductor.

Electricity in the Royal Navy.—During last week trials of electric lighting apparatus took place on board the barbette ship *Collingwood*, at Portsmouth, which has just been turned out of hand by Messrs. Siemens. The whole of the lamps were tested, and some excellent results were obtained, the light being all that could be desired. The torpedo ram *Polyphemus* has been ordered to proceed to Devonport in order that the Signal Committee may have an opportunity of witnessing a trial of the electric night semaphore which has been fitted on board that ship.

Australian Papers please Copy.—The following extracts, when read together, may prove interesting to those who have anticipated the benefit of the reduction of the tariffs, due to the late Telegraphic Conference at Berlin.

"I have received the following letter from a correspondent signing himself 'A Yachtsman':— 'Dear *Truth*,—I am fortunate enough in having inherited some money from my father, which I have invested in various ways. Being passionately fond of yachting, I have, for one thing, bought a yacht, in which I am now cruising in the Mediterranean. The other day we came across a splendid vessel, beautifully fitted, with a gay company on board, and all the indications of a very wealthy owner. I said to my friends: "I should not like to have to pay for the fitting up and expenses of that yacht." On inquiry, I found that the vessel was the *Electra*, and I further discovered, to my intense surprise, that Mr. John Pender, the telegraph magnate, was yachting in her. As some of my investments have been made in the Eastern Telegraph Company, I find I am actually helping towards paying the expenses of that gentleman's yachting excursion, the *Electra* being one of the steamers of the company. I fancy you will be interested in this little game, and so I send you word.' "—*Truth*, March 11th.

"Egyptian news.—The Government have declined to confirm the provisional arrangement proposed by Mr. Floyer at the Berlin Telegraphic Conference. The Eastern Company's position is, therefore, precisely the same as before."—*Daily News*, March 19th.

"Exchange Company's Telegraph, Alexandria, Friday, 5.45 p.m. Mr. Pender having completed his inspection of the Eastern Telegraph Company's stations at Alexandria, Cairo, Port Said and Suez, and also the cable which has been laid along the canal for the company's use, proceeds to Malta on board the company's repairing steamer *Electra*. During his stay at Cairo, Mr. Pender has completed negociations with the Egyptian Government, which will be of great benefit to the Eastern Company and the public using that system. It is proposed shortly to reduce the tariff for press messages from Egypt".—*Exchange Slip*, March 19th, 1886."

The Spiel Petroleum Engine.—Dr. Hopkinson, F.R.S., has given a report on this new motor based upon his tests made therewith. He does not state the price of the oil when bought in large quantities, and therefore the cost of working, which he calculates at $1\frac{1}{2}$d. per H.P. hour, with the addition of say $\frac{1}{4}$d. per hour for lubrication, appears to us open to doubt. By this is meant that we are inclined to the belief that Dr. Hopkinson's figures are in reality too high, not under the mark. From our own observations on this engine and some considerable experience of another of similar construction, we can cordially endorse all that Messrs. Hopkinson and Appleby state in favour of this method of obtaining motive power. We wish the company, just formed for the purchase of the Spiel patents, every good fortune, for if successful the company's operations would be a means of lessening to some extent the injurious effects of the monopoly in gas-engines, although we should not be at all surprised if a legal suit is brought about by the proprietors of the Otto engine. There is, however, one point which we do not see mentioned. Is it likely that any difficulties will arise, for instance with insurance companies, touching the dangerous properties of the oil ?

The Etéve Engine.—What has become of the Etéve petroleum engine ? We had expected ere this to have seen it ready to place on the market. The prospects of many a good apparatus appear at times to be temporarily, if not permanently, blighted, by the inertness of those into whose hands they may happen to fall. We trust that this is not a case in point.

Portable Electric Hand Lamps.—The dimensions of the lamp illustrated in our last week's issue are $5\frac{1}{4}$ by $4\frac{1}{2}$ by $3\frac{1}{4}$ inches, its weight $6\frac{3}{4}$ lbs. This is the lamp to which Mr. W. H. Preece referred the other day in his paper on "Domestic Electric Lighting."

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Admiralty Survey.—We are informed that H.M.S. *Sylvia*, a surveying vessel under the command of Captain Dawson, is now engaged on the Guinea Coast in checking and correcting previous work. The French man-of-war *Inferente* is also doing similar work. Both of these vessels have taken advantage of the recently laid cables to get time-signals, the lines having been placed at their disposition by the West African Telegraph Company.

"Substantially as Described."—Is there any meaning attached to the words above with which claims in patent specifications usually end? Mr. Justice North states that Edison's claim is for "the combination of a tension regulator with a 'diaphragm or tympan,' not confining it to any special form, and I have heard no complaint that the claim is too large in this respect." There is, however, a qualifying phrase, "substantially as described." Does a claim embrace everything which is not described or even thought of at the time of the invention?

The Government and Electric Lighting.—It is refreshing to note that at last a "Liberal" Government has admitted that there is some cause of complaint in the conditions of the Electric Lighting Act of 1882. Lord Houghton's remarks last week were a distinct advance of position on the part of the Government, but something further than that which he promises for the Government Bill is required.

Reform in the French Telegraph Department.—Just before going to Press we received a notification that the following engineers have been appointed chief inspectors, and form the council which will have the direction of telegraph work:—

M. Raymond, formerly chief of the Eastern district of Paris.
„ Loir, „ „ Lyon „
„ Berger, „ „ Tours „
„ Belz, „ „ Marseilles „
„ Berthot, „ „ Lille „
„ Mazne, „ Inspector of Comptrol at Paris.

MM. Balavoine and Berthelin have been appointed divisional chiefs. They were formerly Inspectors of Comptrol.

Fastnet Light Cable.—The *Medina* left Gravesend last Tuesday to repair this cable.

Société Internationale des Electriciens.—Owing to the great increase in the number of members of the International Society of Electricians residing in England, the council of the society has decided that it would greatly facilitate the society's business with those members if it had an official representative in this country, and have accordingly appointed one of their members, Mr. R. Aylmer, M.I.C.E., A.S.T.E., of 42, Parliament Street, S.W., as Hon. Secretary and Treasurer for Great Britain.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Parker's Electric Wire Corporation, Limited.—The first return of this company made up to the 22nd ult. was filed on the 29th ult. The nominal capital is £100,000 in £5 shares; 7,500 shares have been issued as fully paid, and 107 ordinary shares have been taken up. Upon the latter £4 10s. per share has been called, the calls paid amounting to £432 leaving £49 10s. unpaid. Registered office, Palace Chambers, 9, Bridge Street, Westminster.

CITY NOTES, REPORTS, MEETINGS, &c.

The Electrical Power Storage Company, Limited.

THE adjourned fourth ordinary general meeting was held at the Cannon Street Hotel, on Thursday, the 25th March, Sir Daniel Cooper, Bart., in the chair.

Mr. H. Dell, the secretary, having read the notice convening the meeting, the directors' report, which was published in the REVIEW last week, was taken as read.

The Chairman then said: Gentlemen, I consider the most convenient method of transacting the business before us will be to deal with the years 1884-5 at the same time—the discussion must include both years, and my remarks will therefore cover the same period. At the conclusion of the adjourned meeting the fifth ordinary general meeting will be held. The report deals fully with all the points of interest to the shareholders, and I now propose to make some observations upon it and the statement of accounts. You will have gathered from the report that the business of the company has rapidly increased, a marked improvement having taken place during the latter half of 1885, and the prospects for the current year are extremely encouraging. In accordance with the articles of association the accounts of 1884 have been opened for inspection at the offices of the company, and the balances therefrom have been carried forward to the accounts of 1885. You are aware that a heavy loss was made in 1884, but the result of a complete change of management is that in 1885 we have made a profit upon manufacture, and are now also receiving cash remittances from the realisation of our patent interests abroad. We propose to spread the suspense account of 1884—£9,848 19s. 10d. over the next five years, as we consider this amount was not fairly attributable to 1884, but to 1883 as well. The year 1885 shows a gross manufacturing profit of £10,902 17s. 10d. I think you will agree with me that these figures are most satisfactory considering the adverse circumstances we have had to struggle against. We undertook to greatly reduce the expenditure; we have done so, and have at the same time secured thorough efficiency. The net result is that the profit and loss account for the year 1885 exhibits a profit of £2,200 9s. 2d. The past two years has been a period of great anxiety to the directors, and we have all given unremitting attention to the affairs of the company. I would point out that we have not taken any fees, but we intend, with your approval, to take them in future. You see from the balance sheet that, when the shareholders did not come forward sufficiently to support the company, the directors provided the cash with which the present satisfactory position has been attained. The Millwall works are large and amply sufficient for an increased output, and a slight strengthening of the staff, as at present organised, would suffice for this purpose. The manner in which the electrical and engineering work entrusted to the company has been carried out by our engineer (Mr. Drake), the works manager, and the staff, has met with general approval, and a reputation for thorough workmanship has been acquired which has placed the company in the first rank of electrical contractors. In proof of this I would mention two of the latest installations carried out in London, viz., the Bank of New South Wales and Lloyds, as examples of the company's work, which are readily accessible to those desirous of being convinced as to the efficiency of its installation work. A third installation, that for 1,500 lights at the Prudential Assurance Company, is not yet completed, but will, when finished, I do not hesitate to say, stand pre-eminent for magnitude and quality among the electric light installations of this or any other country. The company is now extending the field of its operations, as for example, the lighting of the Folkestone Exhibition, the contract for which has been given to us on satisfactory terms. As a frequent visitor and well-wisher to the town of Folkestone, I am very desirous for the success of this exhibition, and I have no doubt that our staff will make a perfect success of the electric lighting there. We have also contracted to furnish a large number of lights, about 1,000, for the forthcoming Colonial Exhibition, in which I, of course, take a deep interest. The batteries have for some time past given every satisfaction to purchasers, and have been adopted by all the large electrical companies and firms, and by many private gentlemen for their residences. Among these may be mentioned Sir William Thomson, Sir W. Armstrong, Mr. Harben, Mr. Littleton, Mr. Fred. Green, Sir David Salomons, Lord Thurlow, and many others. The directors have personally brought to bear what interest they possess in getting orders for the company, and several installations have already been the result, and they ask the shareholders to assist in the same way with their friends in the lighting of private houses, banks and companies, where their influence may be of much service. In temporary lighting for balls, evening parties, &c., the company is doing good business. Among them, the lighting of Marlborough House for H.R.H. the Prince of Wales, Grosvenor House and Eaton Hall, for his Grace the Duke of Westminster, may be specially mentioned. In the propulsion of boats and tramcars large progress has been made during the past year, and we may expect the progress to continue. On the Continent electrical tramcars are used, as at Berlin and Antwerp, and are having more attention than even in this country, and as regards the propulsion of boats we look for more orders for this class of work from the successful running of the Duke of Bedford's electric launch. A considerable extension of train lighting can also be expected during the current year. The London, Brighton, and South Coast and the South Eastern Railways are determined to meet the wishes of the public for the electric lighting of railway carriages, and other companies have the matter under consideration. In regard to the long continued negociations in the United States, to which I alluded at previous meetings, it is with much satisfaction I have to announce that they have been brought to a successful issue. It gave the directors great pleasure to welcome to England the American gentlemen who, with their electrical staff, have just returned to their own country, after a most thorough study of the methods of manufacture of batteries at Millwall and the installations erected by this company. They are the gentlemen to whom reference is made in the report as

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having recently associated themselves with the New York Electrical Accumulator Company, in which we have a large interest as shareholders, and who by energy and skill in management have already achieved a brilliant success in America in another direction. Mr. Theo. N. Vail, so well known in the States in connection with the American Bell Telephone Company, has accepted the post of President of the New York Electrical Accumulator Company. The outlay in the United States has been necessarily large, but we believe that we shall be now amply repaid. Regarding the foreign business I have nothing to add to what is stated in the report. We are pushing the business and selling the batteries direct throughout the Continent. The suit in Germany relates to a lien alleged to exist against the Faure German patent before it was transferred to this company, and this claim, therefore, affects the payment of the German royalties. I cannot avoid referring to the injury inflicted upon our business by the Electric Lighting Act of 1882, and I rejoice to see that there is hope of its amendment during the present session of Parliament, but we must not relax our efforts for an alteration of some of its most obnoxious clauses. The Bill brought in by Lord Rayleigh in the House of Lords deserves our warmest support. We have to regret the death of our colleague, Mr. William Ladd, which occurred last autumn. I think I have now touched upon most of the points in the report, but we shall be happy to give any further information that may be desired. I may just add, in conclusion, that this is really the meeting for 1884. We merely ask you to approve of this report and statement of accounts and then pass into the 1885 meeting. To do otherwise would be to stop discussion upon 1884 matters, and we think it best to keep the whole open for discussion. I beg to move that the report and statement of accounts now submitted to the meeting be received and adopted.

Mr. J. S. Sellon said: I beg to second the resolution put before you by the Chairman, and in so doing it is of course a great pleasure to be able to say that my long since recorded conviction seems now about to be justified by events—namely, that to this company, if wisely directed, honestly conducted and efficiently managed, will be assigned the foremost position of all the important undertakings connected with electrical industry. When domestic lighting was first initiated, apparently insuperable difficulties supervened, namely, non-existence of any means by which a continuous supply of light could be ensured unless the motive and the generating power were in motion, that is to say, unless the engine and the dynamo were working continuously; and even under such inconvenient and difficult conditions the disadvantages of an unsteady and flickering light, the frequent destruction of lamps and accidental breakdowns were unavoidable. It was this intolerable state of things which made the introduction of a storage system absolutely necessary, and we all know how, in spite of enormous difficulties it has made its way, how the scientific and practical electricians of the present day recognise that no isolated installation is complete or perfect without it. This being so, let us consider our present position: confidence is established in our manufacture, and we all know that progress is making way with rapid strides in the electric light industry. The absolute necessity of a storage system is, as I have said, generally recognised. Experience has been gained, fortunately, during a period when but a limited amount of work could in any case have been possible, and you have as your property intact patents which command the whole field in this branch of industrial work, to which, I think, no limit can be assigned. You have also a competent managing director who devotes his time and energy to your service; under him you have an efficient and trustworthy staff, and I would venture to suggest that you also have a board of directors who spare no efforts to advance and secure your interests. Under these circumstances, it is scarcely difficult to forecast what the future of this company should and will be. If you have such conditions as good management and the control of certainly one of the most important factors in connection with the rising industry of the age, I think, however high our hopes have at any time been raised, they will in the end be fully justified. I will ask you to adopt the report and statement of accounts put before you by the chairman.

A Shareholder remarked that there was one question he would like to ask, whether they might have the report of the auditors before they were asked to pass the accounts. The report of the auditors was, or should be, common to the shareholders.

Mr. Courtenay, the managing director, read the auditors' report, a lengthy document, wherein matters relating to the accounts were elaborately explained. It pointed out that the accounts could not be certified as correct, because an error had been discovered of £6 8s., which there had not been sufficient time to trace to its source.

The Chairman said they thought it better to go on with that meeting rather than delay a fortnight or three weeks, after having sent out the notices, in order to go all through the accounts again to discover the £6 8s. He gave them his undertaking that at the next meeting it should be reported whether the mistake had been traced or not, for they should not allow it to go over.

The Chairman: We now resolve ourselves into the meeting for 1885. It is a source of great pleasure to me to get rid of our previous history up to the end of 1884. If in future we do not have very rosy accounts, I hope at all events we shall have very satisfactory ones, showing profitable business. I move that the accounts of 1885 be adopted.

Mr. Sellon seconded the motion, which was carried.

The Chairman proposed the re-election of the vice-chairman (Mr. J. S. Sellon) and of Mr. J. Irving Courtenay, the managing director. In regard to Mr. Sellon he need hardly say that his knowledge and experience were of great importance to the company. Mr. Courtenay was now their managing director. It was not usual for a managing director to be put up for re-election, and it might be advisable at a future meeting to alter the articles in that respect. Mr. Courtenay had resigned the directorship of another electrical company so as to give more time to the business of this company, and they had been fortunate in securing his services for the term of three years.

Mr. A. L. Noel seconded this resolution, which was carried unanimously.

Mr. Courtenay thanked the shareholders for his re-election, and then read the testimonial of Sir William Thomson to the excellence of the company's secondary batteries, which testimonial appeared in the Correspondence columns of the REVIEW last week

Mr. G. Cawston called attention to the balance sheet, in which the balance of trading account was shown to be £10,900; on the other side of the accounts £3,800 were set down for the expenses at Millwall, there being thus shown a net profit of £7,000 on the trading account. The large sum of £2,500 appeared for expenses in London, and this seemed to him a most extraordinary amount, seeing that the work was all done at Millwall. The actual profit on the concern was by means of these and other expenses brought down to £2,200. He wished, also, to call attention to the matter of the royalties, which had only brought them in £130, whereas they had paid out £1,000 in law expenses and patent fees. He thought the net profit ridiculously small compared with the large amount of work carried on at Millwall.

Mr. Courtenay said if the expenses of the head office were, as Mr. Cawston asserted, very high, he could only say that they were a great deal lower than they had ever been before. He had no hesitation in saying that if Mr. Causton went through the items of the expenditure in connection with that office, he would see that it was worked more economically than most offices in London. It must be remembered that the engineer's and other salaries went against the head office. With regard to the law expenses, they had had two heavy law suits, one in which they were sued by their former works manager for summary dismissal. The other was the Elwell-Parker suit, which was satisfactorily settled by Elwell-Parker agreeing to pay them royalties. There were, of course, no royalties from them in this account; they would come into the accounts for next year. The royalties in the accounts were foreign royalties. Then there was the further question of the other law charges. If they did not think fit to protect their patents in this country and abroad they might as well retire from business; because people were not going to pay them the price of a patented article for that which any other person might manufacture. The directors would proceed against anyone infringing their patents; they were bound to protect their property, and just recently, by protecting their property, they had been able to earn solid profits. He hoped the expenses would not be so heavy in future—he did not think they would be. There was a dispute in Germany about the title of one of their patents, and they were receiving no royalties pending the issue of the suit. They were advised that they had a good case, and they proposed to press for payment of the royalties. Then, again, in America, they had satisfactorily settled matters there; the interest they had in New York was most valuable property. They had had very heavy expenses there, but it would all come back, and, what was more, it was coming back. He was much mistaken if, before the end of the year, they did not receive a great deal more money from abroad than they paid out, and for those very patents they were now defending: that was to say, the outlay for this year would be much less than the cash they would receive. But they could not expect to get anything if they did not defend their property. The directors were just as much for peace as was Mr. Causton, but when it came to war they were determined to protect the company, and in this he hoped the shareholders would stand by them.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., were then re-appointed, after which

Mr. Schiff, after applauding the general conduct of the directors, making special reference to their praiseworthy reticence regarding matters better not publicly discussed, said what fell from the Chairman with regard to the future was very satisfactory, and he believed he was only doing his duty if he emphasised the words with which he (the Chairman) had referred to the engineering department of the company, which formed a very necessary part of the concern. He proposed a vote of thanks to Mr. Drake, the engineer, Mr. Gorham and the staff of the company.

General Penney seconded the motion, which was unanimously accorded.

Mr. Cawston moved a vote of thanks to the Chairman and directors, which was seconded by Mr. Noel, and agreed to amidst acclamation.

The Chairman, in replying, said the company had the very best of the directors' time. Things were much more cheering now, especially when they met with the approval of the shareholders in what they had done. He (the Chairman) was quite certain, as month by month passed, they would attain a solid and satisfactory position; and it was the encouragment they now got from the shareholders and the public, that cheered them on. The engineers wished and were encouraged to do all the work in as perfect a manner as possible, and not to go in for a large quantity of work and do it in an indifferent manner, which would only cause a want of confidence; but, he might say, that if the Act of 1882 were altered,

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which it must be, for it was perfectly unworkable, they hoped to very largely increase the working of the company, without increasing largely the expenses.

The meeting then terminated.

Western Counties and South Wales Telephone Company.

THE first annual ordinary general meeting of this company was held on March 25th, at the Grand Hotel, Broad Street, Bristol, Mr. Chas. Nash, chairman of the Board of Directors, presiding. There was a very limited attendance of shareholders.

Mr. H. F. Lewis, general manager and secretary, having read the notice convening the meeting, the report, which had been printed and circulated amongst the shareholders, was taken as read.

The Chairman, in moving that the report and audited accounts be adopted, observed that though that was the first annual meeting of their local telephone company, the accounts comprised 16 months' work, that was to say, from the 1st of September, 1884, to the 31st of December, 1885. The date of holding the meeting was somewhat later than intended, some delay having arisen in consequence of the accounts being a little complicated at first. He hoped that on the whole the shareholders would consider that the result of the working had been satisfactory. He was not going to dwell on the figures, for he thought that the accounts put them very clearly, and scarcely required any explanation. Great care had been taken to charge the revenue with everything applicable to revenue, and that point was particularly noticed by the auditors, who spoke favourably on it, and in the way the stock account was kept. Mr. Lewis was, in fact, complimented on the stock account being kept in a more complete way than almost any others which the auditors had met with in their experience. One-fifth of the preliminary expenses, and one-tenth of the cost of the furniture had been written off, and they proposed to begin a reserve fund against depreciation of plant by setting aside £500. So much for the accounts, and turning to the future he thought they might all of them be reminded that the telephone in this country was quite in its infancy. In England they had about 32,000 telephones, whereas in America there were 325,000. Some people imagined that the great spread in America was because the rates were lower, but in New York the rate appeared to be £30 and upwards, whilst in Bristol it was £15, and the highest rate in Great Britain was £20 a year. In most of the large towns in America the charge was £25, but in New York alone there were more telephones than in the whole of the United Kingdom. He thought they might fairly assume that gradually, and perhaps rapidly, the telephone would increase in use in their own country. In Bristol there had been a steady progress, and if they looked at other places in their district they found that Plymouth and Torquay were likely to afford a considerable increase in their business. They had opened an exchange at Bournemouth, which had commenced in a most satisfactory manner. At once there were about fifty subscribers, and they looked forward confidently to having at least 100. Mr. Lewis, the secretary, was present, and looking over the report of the proceedings he (the chairman) observed that they looked upon him there almost as a public benefactor. They were preparing to open exchanges at Bath, Gloucester, Sharpness, Weston-super-Mare, Worcester, Malvern, and many other places, but perhaps the most important part of their district was South Wales. Trunk lines were to be established—were, in fact, in progress between Bristol, Cardiff, Newport, Swansea, and Llanelly, and the chairman pointed out that by an extension from Cardiff to Pontypool, and to the Rhondda Valley, Aberdare, and Merthyr, they hoped to have a network of wires to the various works and collieries in the neighbourhood. The chairman said he would like to remind their friends of the great extent of district that the Western Counties and South Wales Telephone Company possessed. Looking at the extent of surface, it was more than one-fourth of the whole of England and Wales. It was true there were not many large and populous towns, but there were a great many towns where they might look forward to a considerable telephone business. In Cornwall, he believed that the mining centre about Camborne was likely before very long to be an important telephone district for them. (Hear.) He observed that free communication had been given to their charitable institutions, and a few days ago Mr. Cave, the president of the infirmary, mentioned how thankful the staff felt that telephonic communication with the infirmary had been given. The advantage of the telephone system in case of fire had been proved over and over again, and only on Saturday last its usefulness to the police was shown in the case of a demonstration of the unemployed. Finding out what the route of the procession was likely to be the police were enabled to telephone to the various stations, so that a body of police could be placed on the line of route, and that could not have been done without the telephone. The chairman then formally moved the adoption of the report and accounts, and the declaration of a dividend of 6 per cent. on the paid up preference shares.

Mr. Mark Whitwill seconded the motion, and said, like Mr. Nash, he believed that the use of the telephone was yet in its infancy. It was coming, however, to be regarded as one of the necessities of life, and nothing was likely to check its growth unless it was the obstruction of local authorities.

Mr. J. B. Morgan (of the United Telephone Company) said that as one of the largest preference shareholders it was pleasing to him to observe that that was the first of the companies that had placed a sum to reserve account in the first year of its existence.

The resolution was unanimously adopted.

On the motion of the Chairman, seconded by Mr. H. Fedden, it was resolved that a sum of £500 be placed to a special reserve fund for depreciation of plant.

Mr. Chas. Nash, Mr. Mark Whitwill, Commander Forsyth, R.N., Mr. Henry Fedden, Mr. Thomas Pole, and Mr. Richard Cory were re-elected directors, and Messrs. Tribe, Clarke, and Co. were reappointed auditors.

The Chairman said they had in Mr. Lewis, the secretary and manager, a most valuable officer, and he thought they should not leave without exgressing the opinion they entertained of Mr. Lewis's services.

Mr. Morgan seconded the resolution.

The resolution was carried by acclamation.

An extraordinary general meeting was then held for the purpose of making certain alterations in the articles of association, and resolutions approving the same were unanimously adopted.

A vote of thanks was passed to the chairman, and the meeting terminated.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—This company notifies that the accounts to the 31st of December last show, subject to audit, a profit balance of £164,188. After payment of three interim dividends and a bonus of 2s. per share, and charging £55,062 against revenue during the year on account of cable renewals, &c., the directors propose to pay on the 15th inst. the usual dividend of 2s. 6d. per share, together with a bonus of 2s. per share (both tax free), making a total payment of 7 per cent. for 1885. The balance of £41,625 has been carried to the reserve fund, which now stands at £567,802.

The Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 3s. per share on the preference shares, less income-tax, and of 1s. 6d. per share on the ordinary shares (income-tax having already been deducted), for the quarter ending April 18.

India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—Application has been made to the Stock Exchange Committee for a settling day and quotation for the recently issued £200,000 four-and-a-half per cent. debentures of this company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 26th were £2,099, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 26th amounted to £2,544.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, March 25th, Professor HUGHES, F.R.S., president, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, a paper on "Electrical Lighting by means of Low Resistance Glow Lamps," was read by Mr. ALEXANDER BERNSTEIN, foreign member.

It is not uncommon in the history of technical science to find that constructions which have at one time been abandoned on account of apparently insurmountable difficulties have after a certain lapse of time, been readopted. The high speed engine, the high pressure boiler, the multiple telegraph system, were known and made long before they were generally applied, because their practical application was impossible until a certain amount of experience had been obtained by means of the low speed steam engine, the low pressure boiler, and the single telegraph system.

In a very similar manner the low resistance glow lamp was known and made more than thirty years ago, but has hitherto been considered impracticable. In the meantime the glow lamp of high resistance has made its way, and has met with considerable success. Now to-night I desire to revive the older type of lamps in a new form produced by means of our present experience, and to show at the same time the way in which these lamps may be made to answer the purpose of electric lighting.

As we have been so often told that the lamp of low resistance is neither practical or economical, I must suppose that most electricians are somewhat prejudiced against it. But prejudices are detrimental to the development of truth, and I must therefore request you to take as impartial a view as possible of the case which I shall lay before you to-night.

High or low resistance of glow lamps is not merely a question of construction of the lamp itself; it is a question of principle which determines the whole system of lighting. The requirements of the dynamo, the sizes of the conductor, and the whole system of arranging the circuit, are entirely dependent upon the lamp which we select. It is therefore not sufficient to compare different types of lamps in regard to their qualities as lamps; it

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is quite as essential to consider how the use of these lamps answers the practical purpose of electric lighting. I shall therefore divide my paper into two parts—the first dealing with the lamp itself, the second with the manner of its application.

In speaking of glow lamps, and considering their merits, I shall only take those lamps into consideration in which carbon is brought to a state of incandescence, and emits light by reason of its elevated temperature. Although other substances may be used, experience has shown so far that none of them offer the advantages which are secured by the use of carbon, viz., the possibility of applying a very high degree of temperature. This is very essential, because the highest temperature implies the greatest efficiency; and efficiency, together with durability, are the two qualities which principally determine the merit of an incandescent lamp.

Before proceeding any further, allow me briefly to enumerate the principal parts which constitute an incandescent lamp. These are only four—the glass bulb, the conducting wires (which always consist of platinum as far as they are surrounded by glass), the light-giving carbon, and the connection between the carbon and the wires (generally called the mounts). The simple construction of such a lamp does certainly not indicate that its manufacture is beset with so many difficulties. In order to settle our terminology, I shall further mention that the reciprocal of the number of watts required for every C.P. of light emitted will be called the "strain;" so that the strain is small if the number of watts per candle is comparatively large.

The light which is emitted by incandescent carbon depends only upon its temperature and the amount of its radiating surface; but the energy which is required to maintain this light would be determined—irrespective of the losses which may occur in the lamp, and under the supposition that the state of vacuum and the exterior temperature remain unaltered—by those same two magnitudes alone, if the radiating power of all carbon were alike. It seems to me that this last is not the case. From certain analogies, well known in physical science, we may conclude that a black, sooty carbon will radiate more heat than a carbon of a dense grayish surface raised to the same temperature, and consequently the former will require a larger supply of electric energy to maintain it at the same temperature than the latter. This fact seems entirely borne out by observations made on glow lamps.

Let us now consider the peculiarities of a glow lamp of high resistance, say of 100 volts and 0·6 ampère. I select this lamp because it seems that this is approximately the highest resistance lamp which can be practically applied at the present time. At least, I can see no reason why the complicated expedient of a multiple wire system should be used, if electric lamps can be made reliable when working at a much higher difference of potential and with a corresponding smaller current. As the lamp is only to take 0·6 ampère, the filament must be exceedingly fine in order to become sufficiently heated by this current, and moreover, the filament must be of sufficient length to obtain the necessary amount of light-giving surface. As soon as the current is passed through the filament, the latter is raised to a certain state of incandescence; and we shall therefore have to deal first of all with the effect which heat alone seems to have upon the carbon.

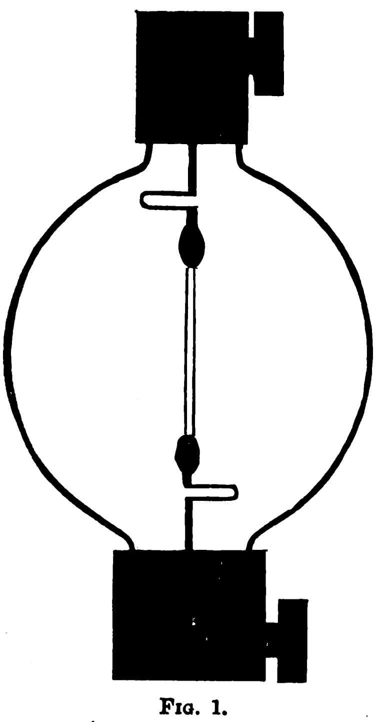

FIG. 1.

Heat has a general tendency to expand all substances; and as it was interesting to know how far carbon is subject to the same law, I have investigated this question by means of a lamp of the following construction:—Two straight filaments are connected by means of a cross piece of platinum in the form of a T, which acts on a lever so arranged as to indicate ten times the elongation of the filaments when these are heated. The annexed sketch (fig. 3), in which A A are the filaments, and B the indicating lever, shows the arrangement which was adopted. The experiment indicated that when the carbon was exposed to a strain of 3 watts per candle, the elongation of the filaments amounted to 120th part of their length. It was further noticed that the rate of expansion was not constant, but increased with the temperature, although at the highest temperatures obtained the coefficient of expansion seemed to decrease again.

The fact that the carbon expands and contracts with every change of temperature explains why lamps with slender filaments are destroyed more quickly when subjected to varying currents than when they are fed by a constant and uniform current, such as that supplied from batteries.

When we look at a heated filament, we notice sometimes that one small spot is brighter than the rest of the filament. This is an indication of a flaw which will sooner or later produce the disintegration of the carbon at this particular spot. These flaws are, for the most part, so minute that they cannot be perceived in the filament when cold, and only gradually show themselves when the lamp is being used. This is one of the causes which produces premature destruction of the lamp. The finer the filament the greater the danger of a flaw.

It has lately been supposed by some writers on the subject that the life of a glow lamp is in direct proportion to the diameter of the filament. Such suppositions, which are mostly made for the sake of obtaining mathematical formulæ, are far too sweeping; and all we are entitled to say is that, *cœteris paribus*, the lamp with a thick filament promises greater durability than the one with a thin filament.

We have before observed that heat produces expansion of the carbon, and from this we may infer that if the heat is sufficiently high, evaporation or disintegration of the carbon would be the result. Such is the case if the carbon is of a soft quality and raised to a very high degree of temperature; but we are fortunately in a position to produce a carbon of such dense and hard structure that there seems to be no perceptible disintegration at the temperature usually employed in incandescent lamps. If we, nevertheless, observe in high-resistance lamps—even if worked at a strain of no more than 4 to 5 watts per candle, and a corresponding low temperature—that the carbon filaments are disintegrated, that the resistance of the lamps consequently increases, and that the glass bulbs begin to blacken, we are led to suppose that other forces must be at work which produce the destruction of the lamp. These forces are of an electrical nature, and their existence is easily explained if we consider that an electric glow lamp is at the same time a vacuum tube.

In the high-resistance lamp we have considered before, there is a difference of potential of 100 volts between the two terminals of this vacuum tube. The fact very soon makes itself apparent in the lamp. If the temperature is sufficiently high, the negative side of the carbon assumes a dark, sooty appearance, and a deposit of black loose carbon is formed on the positive platinum and mount. This action of throwing off particles of carbon from the negative side towards the positive has been the subject of a very interesting paper communicated to the Royal Society by Mr. Preece. The peculiar behaviour of high-resistance filaments is evidently the effect of a combined action of heat and electricity. The heat lessens the attraction of the particles for each other, and the electric forces produce motion. The result is the gradual deterioration and ultimate destruction of the carbon.

It has often been noticed that a blue flame makes its appearance upon the positive platinum when the carbon is raised to a high state of incandescence. As no explanation of the production of this blue flame has as yet been given, I beg leave to insert here a few words respecting the most probable cause of it.

All platinum, when cold, occludes a large quantity of oxygen, which is given off again when the platinum becomes heated. The black, sooty deposit of carbon on the positive platinum is just in a condition to combine readily with the oxygen, and both together form the blue flame. While the lamp is on the vacuum pump this flame may often be seen to travel up and down the platinum wire, always appearing where occluded oxygen is set free. If the pumping continues without the current being increased, the quantity of free oxygen is soon consumed, and the blue flame disappears, but reappears again if the temperature of the platinum is increased by increasing the current. Just in the same manner finished lamps will, under all normal conditions, show no blue flame, but will do so if an excessive current is passed through the lamp. In this case a blue flame is sometimes seen on the negative platinum as well. This occurs because particles of carbon find their way to the negative platinum and are oxidised there in the same manner. As the spectrum of the blue flame has been observed by Messrs. Liveing and Dewar to be that of carbonic oxide, it seems so much the more probable that the explanation here given is correct.

We have now to notice another effect of the vacuum tube. When lamps are made for very high difference of potential and corresponding small current, there seems to be a very strong tendency of the current to leap across from one terminal to another, thereby short-circuiting the lamp, destroying the filament, and fusing the platinum wires. This tendency is very strong when the current is turned on suddenly, as the carbon, being cold, then offers the highest resistance to the passage of the current.

One of the conditions which it is desirable to observe in respect

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to a practicable lamp is that a certain excess of current such as is liable to occur in installations must not be able to destroy the lamp; and in this respect it is certain that the lamp with a thick filament is far superior to the lamp with a thin filament.

Turning to another point of practical importance, we notice that lamps with fine filaments are exceedingly subject to flickering as soon as the strength of the current varies but slightly. Variations of this kind may have their cause in irregular motive power, in slipping of a belt, or in a dynamo which is not perfectly balanced either mechanically or electrically. Such flickering will be noticed in a great many installations with small-current lamps, and is exceedingly disagreeable to the eye. Now, with a large hollow carbon used in the lamp which I shall presently describe, the interior is always at a higher temperature than the exterior, and serves as a reservoir of heat which allows for certain variations in the current without any effect on the eyes as regards the light.

How are we, then, to obviate these difficulties appearing in the lamp? If the thin filament does not promise much durability, and is disadvantageous in other points mentioned—if the high difference of potential proves to be a factor in the destruction of the lamp—we must employ thick filaments and a small difference of potential; or, in other words, we must produce a low-resistance lamp.

I think I have sufficiently shown you the right of existence of a low-resistance glow lamp, and I shall now proceed by describing the lamp which is before you, the form of which seems to be one of the best of all the varieties of low-resistance lamps which I have made since 1882.

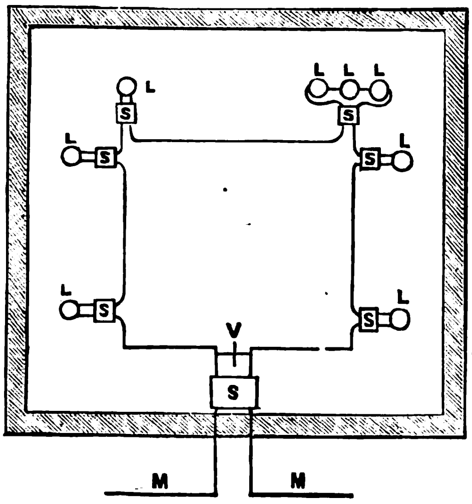

Fig. 2.

The lamp which is shown in figure 1, consists of a glass bulb of oval shape, into the opposite ends of which the platinum wires are sealed. In this manner the glass is placed symmetrically round each wire, and is therefore less liable to crack when heated. The carbon has the form of a straight tube mounted upon short pieces of stout platinum, which are joined to the platinum wires passing through the glass by means of flat thin copper strips, bent upon themselves so as to form springs at right angles to the direction of the carbon. In this way all parts of the lamp can expand and contract without subjecting the carbon to any injurious strain. A cap of insulating material at each end of the glass bulb provides for proper connection with the conducting wires, which may be made to support the lamp; and this connection is made in such a manner as to prevent accidental contact of the manipulator with any part carrying a current.

The success of these lamps depends on the satisfactory construction of every one of its details in an almost equal degree. The quality of the carbon, the way in which the same is mounted, the manner of surrounding the platinum wires with the proper kind of glass, the avoidance of any mechanical strain, and the proper proportion of every part of the lamp, are all the results of tedious experiments, which were necessary in order to produce a satisfactory lamp. The electrical dimensions of the lamp are as follow:—It requires a current of 9·75 ampères, thereby showing a difference of potential of 7 volts, and a hot resistance of about 0·7 ohm.

When speaking of the high-resistance lamp, I have mentioned that there seems to be a limit to the difference of potential which we can apply in each bulb. As regards the low-resistance lamp, there is a limit to the strength of the current of which we can avail ourselves. The difficulty rests with the wires, which have to be sealed air-tight into the glass, as it is far easier to seal in thin than thick wires carrying a large current.

Before concluding this first part of my paper, I shall have to mention one of the drawbacks of the low-resistance lamps, to which Professor Forbes has called attention in his excellent lectures on the distribution of electricity, viz., the loss of heat in the conductors inside the lamp. I quite agree with Professor Forbes that in older types of lamps the loss was very considerable, and a serious question; but in the lamps which I made some years ago this loss amounted to only one-tenth part of the energy consumed. I am happy to inform you that in the lamp before you this loss has been reduced to one-twentieth part of the energy required in the lamp.

I shall now turn to the second part of my paper, and I shall consider it best to attack at once the most difficult problem which can present itself, viz., the supply of a large number of lamps from one central station, with the condition that all the lamps can be used entirely independent of each other, and with the further condition that the expenditure of mechanical energy shall always be proportioned, or, at all events, approximately proportioned, to the number of lights in use. Our imaginary plant is to be arranged for 6,000 lamps, requiring 9·75 ampères, and upon the average 6 volts each. Let us first look into the central station and consider its requirements. We shall settle upon the use of a dynamo which with a current of 10 ampères is capable of producing an E.M.F. of 2,000 volts—a kind of dynamo which was first applied by Mr. Brush, and which is already extensively used for arc lighting, or for a combination of arc lights with groups of glow lamps, several of the latter being always arranged in parallel. But the lamps of which I spoke at greater length in the first part of my paper are made for the passage of the whole current, and will therefore be arranged in series, one being placed in the line after the other. In this case there will be more than 300 lamps on each line; let us say 300. We shall therefore require 20 such dynamos, and one or two spare machines in case of repairs. These 20 dynamos may be driven from shafting, or each by a separate steam engine. There are 20 separate lines proceeding from the central station, and as the main condition of our system is that the current on every line must always be kept constant, we must provide for the regulation of each dynamo in such a manner that the E.M.F. always corresponds to the number of lamps which are in use. This regulation can be effected by automatic devices, or may be done by hand in adjusting the magnetic field or the speed of the dynamo. An ampèremeter which is placed in every circuit will indicate whether this condition is fulfilled, and a voltmeter connected with the terminals of each circuit will inform us how many lamps are used on each line at any time. A registering voltmeter placed in the same manner would be another useful addition. The central station, furthermore, contains a switch-board, which allows any one of the circuits to be connected with any one of the dynamos. If we presume that the station is to supply current day and night, it would certainly be absurd to run all the dynamos constantly at those times, when only a small number of lights are required. At daytime, then, I should propose to loop several circuits together, and if the total number of lamps is sufficiently low, all the 20 circuits might be looped in a single one, so that only one dynamo need be kept running. By means of an auxiliary line of lamps in the central station, dynamos and circuit may be switched in and out without any sudden change in the conditions of either. The system of working would then be that in the afternoon one dynamo after the other is switched into its respective circuit, the requirements of which can always be ascertained on the voltmeter of this circuit. If the consumption of light decreases, the dynamos are gradually switched out again. By the addition of an arrangement for observing and measuring the state of insulation of every line, the outfit of the central station might be considered complete. I have not mentioned any apparatus in connection with the central station which could not be easily constructed with the means at our disposal at the present time.

We now leave the central station, and turn our attention to the conductors. These are 20 pairs of copper wires of small size, say No. 6, well insulated. Experience has shown, so far, that there seems to be no great difficulty in insulating a wire if the tension of the current is not more than 2,000 volts. If we suppose that the central station is in Pimlico, on the banks of the Thames, a few wires may be laid in the direction of Victoria Station, a few more may reach the Houses of Parliament, some may be laid in the direction of South Kensington Museum, and some others may be used for lighting private houses—in each of which I shall suppose that, upon an average, 20 lights are used at the same time. In this case 15 houses are passed by the same conductor, which supplies current for 300 lamps. All these lights can be turned on or off at will, quite independent of each other, because we have provided in the central station that each dynamo is regulated in such a way as always to produce the same strength of current, no matter whether there are 300 lamps alight in each conductor, or only 10.

Let us now compare this system with the only other system in which glow lamps are arranged quite independent of each other, leaving out the consideration of secondary generators. In the parallel system the central station must be in the centre of the district to be lighted, which is often very objectionable, and sometimes impossible. In the series system the station may be far out of the way. In the parallel system we are restricted to the use of a 100-volt lamp, as we have seen before, and, in consequence, the radius of the district to be lighted must be kept very small, or the expenditure for conductors would be prohibitive. In the series system the expense for conductors is comparatively small, and we may reach any distance. The parallel system requires that a fixed difference of potential should be maintained in all the conductors under varying strength of current—a condition with which it is even theoretically impossible to comply, and which entails enormous practical difficulties. In the series system we have to maintain a constant current under varying resistances—a condition which can be easily fulfilled. When the parallel system was first developed, the prevailing idea appears to have been to make electric lighting from central stations similar to gas lighting. But the conditions under which electrical energy in its

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active form is best transmitted are so different from those requisite for the transmission of the potential energy of gas, that the desire to imitate the gas system has proved rather a disadvantage.

We now arrive at the last, and perhaps the most difficult, part of the whole installation, viz., the outfit of the place which is to be provided with lamps. For the sake of simplicity, I will suppose the place to consist of one single room, as shown in the sketch.

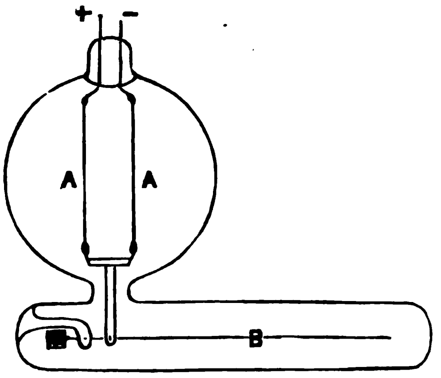

Fig. 3.

In this sketch (fig. 2) the small circles marked L represent lamps; the squares marked S represent switches (which will be presently described); and the cross +, marked V, is to indicate a registering voltmeter. The street main, M, enters the house at the main switch, drawn larger than the others; it continues from switch to switch, and returns to the main switch before leaving the house. We have supposed the street mains to be composed of No. 6 copper wire, but the house mains may be made equal in section to No. 10 wire, in order to be more flexible. The lamps are always connected to their respective switches.

From what has been said before, it is quite evident that the first and essential condition of such a system must be that the circuit is never to be opened, whatever may happen. As we are always dealing with a closed circuit, it will prevent misunderstanding if we give a different designation to the two ways in which the circuit can be completed; and I shall therefore call the circuit "short-closed" if the current goes directly through the switch lever, and "long-closed" if the current is led through the lamps or other electric devices, such as motors, which are to be acted upon. The fact that the circuit is never to be opened reduces one great difficulty in the switch required in the parallel system, viz., the liability to produce an arc.

The main house switch, to which I shall now invite your attention, serves the purpose of either short closing the street circuit, so that no current can pass into the house, or of long closing the same, thus including the house circuit into the main circuit. In the first case I have not considered it sufficient merely to prevent the current from entering into the house; I have thought it advisable to disconnect the house circuit entirely from the street circuit at the same operation, so that any alteration of the circuit may be made inside the house without the possibility of a branch current being established, even if the street circuit should be of defective insulation. But this switch is also made to answer another purpose. Supposing that the street circuit, which has been short closed, is now to be long closed, but that by some accident or another a break of the continuity of the line has occurred in the meantime inside the house: if now the switch lever were to be moved with the intention of allowing the current to enter the house, the result would be the formation of a long arc, and eventually the whole current would be interrupted. The manner in which this has been rendered impossible can be best explained by reference to the annexed sketch (fig. 4), in which A is the switch box, made of insulating material, and L the switch lever, made of conducting material. C, D, and E are three pieces of metal let into the upper edge of the circular box. The lever, L, may occupy three positions, marked 1, 2, and 3. In position 1, C is connected with E, and as C is one terminal of the main circuit and E the other, this circuit is now short closed. But if the lever L is in position 1, it lifts two flat springs of metal, F and G, which are the terminals of the house circuit, from their respective seats on the metal pieces, C and E. The lever, L, carries on its upper side two pieces of insulating material, on which the two springs, F and G, now come to rest, and consequently the house circuit is out of all electrical connection with the main circuit.

If it were now intended to allow the current to pass into the house circuit, the lever, L, would have to be turned from position 1 to position 3; but when the lever passes over the intermediate position 2, it first connects the metal piece D with E. But the metal piece D is permanently connected with C by means of the resistance, R, and the main current will therefore be divided in two parts—one, the greater portion, passing through R and L to E; the other, the smaller portion, passing through the house circuit in case the same is complete. This house circuit includes the electro-magnet, K, which is situated inside the switch, and the armature of this electro-magnet carries a pin, P, which is in such a position that it is below the plane of the motion of the lever L if the armature be attracted, but hinders this motion if the armature be not attracted. In case, then, that the house circuit is complete, there will be no impediment to the further motion of the lever, L, from position 2. It will therefore reach position 3, where it rests upon pieces of insulating material, and the whole current now passes through the house circuit. But if the house circuit had not been completed, the motion of the lever would have been arrested by means of the pin, and a break in the circuit is in this way made a matter of impossibility.

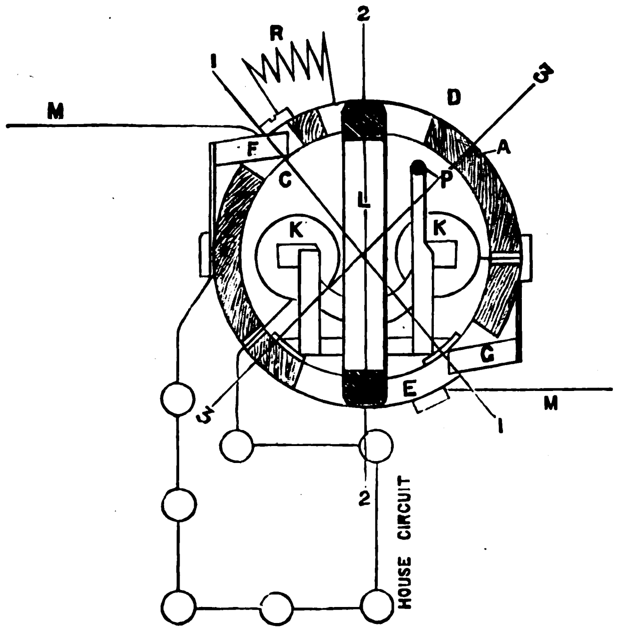

Fig. 4.

I shall pass at once to the lamp switch, because it is practically a mere repetition of the main switch on a smaller scale. But the lamp switch contains an additional arrangement, which would be a useful adjunct to the main switch as well, viz., the automatic cut-out. This is intended to act if the lamp should fail during the passage of the current, in which case the break of the circuit is prevented by short-closing it around the lamp. The arrangements which I have used to provide for this eventuality are of two kinds, and may be shortly described without reference to any drawing. Both are based on the principle that if the resistance of the lamp increases—which always occurs in lamps placed in series when the carbon gives out and an arc is formed—then a current in a shunt around the lamp will increase. In one of these arrangements this increased current is made to act upon the armature of an electro-magnet, which armature releases a spring for the purpose of making a direct secure contact between two places of the circuit in which the lamp is situated, and a short circuit is thereby formed round the lamp. In the other arrangement a fusible wire is placed in the shunt, and a lever is arranged in such a way as to be acted upon in one direction by the wire, and in the other by a strong spring. If the wire fuses, the spring presses the lever against contact pieces, which serve the same purpose as specified above. In neither case can the circuit, which is now short-closed, be made to include the lamp again until the cut-out lever has been moved into its former position by hand. The combination between the switch and the cut-out lever is such that the switch-lever has to be placed into position 1, before the cut-out lever can be operated upon by hand. The reason for the adoption of this last arrangement will become evident by a consideration of the peculiarities of the switch which I have mentioned before. I believe that in this way I have provided for the prevention of a break in the circuit which may occur from any eventuality.

I need not dwell on the construction of the lamp-holder, the only part of the outfit which has not yet been mentioned. It may be made in different ways, but one principal idea has been adhered to in its design, as well as in that of all other details which constitute the outfit of a house; there is no part conveying a current which is not perfectly insulated, or which is in any way exposed so as to offer the possibility of any person coming into contact with it. This is hardly possible in arc light circuits, but may easily be done where only glow lamps are used.

And this brings me to the last question which I shall have to consider, namely, the question of safety. Here again I shall have to note one very great advantage of the series system over the parallel system, and this is the impossibility of a wire becoming overheated. Every experienced electrician knows as a fact that short circuits in the parallel system have often led to detrimental results in spite of safety fuses; and a system in which such a danger does not exist, and which consequently does not require any provisions against it, has certainly much to recommend it. Especially in such cases in which the danger of fire must be most dreaded—in ship lighting—I believe that this advantage of the series system will be very greatly appreciated.

I now come to the objection generally raised against the use of

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high tension currents. If an inventor were to appear to-day saying he wanted to introduce into our houses a substance which, when properly used, was intended to give light, but which in itself was a poison, and produced poisons when used as a light, and of which it was further known that it was always ready to form an explosive agent when mixed with atmospheric air, I believe that the critical spirit of our time would raise an outcry against the introduction of such a dangerous substance, and against the use of the public streets for its conveyance. But this substance—of which we know that it is quite harmless as long as it is retained within metal tubes—is now actually carried into all our houses, and we are so familiar with its peculiarities that no one feels any nervousness nowadays in the neighbourhood of a gas chandelier.

In conveying a high-tension current into a house we are in a far more favourable position than if dealing with gas, because the probability of an accident is far more remote. Three conditions must be fulfilled before any person can be injured by an electric current. First, there must be a certain amount of leakage on the line; secondly, the person must be in contact with a bare conductor; and, thirdly, the person must at the same time be in contact with the ground.

In the system of central lighting which I have laid before you it is easy enough to constantly ascertain the condition of the line, and far easier to locate a fault than in a complicated system of branch wires. It is, further, easy to construct all parts of the system inside a house in such a manner that contact with a bare conductor is impossible; and, moreover, a person standing on a carpet and a dry wooden floor is exceedingly well insulated. The tension which we can use with safety depends simply upon our means of insulation. If you will recall the precautions which have been taken in the construction of the switches by entirely disconnecting parts of the circuit from the main circuit, when lamps have to be replaced or alterations to be made in the circuit, then I think you will agree with me that the probability of an accident is exceedingly remote; and this system of lighting appears to offer more safety than any other method of artificial lighting at present in use.

And now, in conclusion, I should like to say that in a short paper like this which I have had the honour of reading to you, I found it impossible to enter more fully into details than I have done, and I have therefore restricted myself to the explanation of those details and the discussion of those questions which appear to me of prominent importance. I hope that by my humble efforts I may have accomplished the object of my labours, namely, the further extension of the field of electric lighting.

In the discussion which followed the reading of Mr. Bernstein's paper,

Mr. Preece said none but those who have actually had the electric light fitted in their houses can possibly have any idea of the great advantage and comfort of the method of illumination. The introduction of the electric light into dwelling houses he contended would do more good than any of the arrangements suggested by sanitary institutes. He objected to the use of the word "strain" as applied to the number of watts per candle at which a lamp was worked, especially as the term was very ambiguous in its meaning. Mr. Bernstein had laid great stress upon the fact that high resistance filaments are very well in their way, but that they are very expensive. What we want is cheap forms of lamps worked at a high power for a moderate period—say, 200 hours; such lamps would probably be the most economical in the end. A great point about the series system of working lamps was the non-liability to short circuiting. This short circuiting was a most serious matter in the case of the parallel system. He had come to the conclusion that there were as many dangers in electric as in ordinary methods of lighting unless proper care was exercised in putting up the installation. The result of a main breaking down in the series system was a point which must not be overlooked. He considered Mr. Bernstein's paper was one of great interest.

Mr. Rawson said that with reference to the construction of incandescence lamps, they had to rely to a great extent upon secrecy in the matter, and he could not therefore say much as to his own experience. He would ask how joints would be made in a series system in which the current had continually to be kept on, as it must be in some installations. He thought it a pity that the use of accumulators had not been mentioned. The question of the occluded gas in the mounts of the filaments was, he thought, a difficulty which had to be got over. Did the lamps alter in resistance from use? He thought that safety junctions ought to be placed at every lamp, and not at every room only, as advocated by Mr. Preece in his paper before the Society of Arts. With reference to the "flaming" mentioned in the earlier part of the paper, he thought that this was due to the vacuum being imperfect. The temperature at which the lamp was burnt was he considered too high for durability. The question of short circuits from leakage in the series system, due to accumulation of moisture, was, he believed, a much more serious difficulty than might generally be imagined.

Mr. R. E. Crompton pointed out that Mr. Swan, when he first took up the manufacture of incandescence lamps, had intended to work on the same lines as Mr. Bernstein had; but he (Mr. Crompton) had dissuaded him from doing so. He thought the difficulties in connection with the series method of working were enormous; if double earth faults occurred, the system will be very dangerous—indeed, he doubted whether the Board of Trade would sanction the use of the high potential necessary for the system. Short circuits through the body took place often in a most unexpected way. He differed from Mr. Bernstein as regards the high efficiency of lamps; he considered 50 and 110 volt lamps to be equally good. A good Swan lamp should last 2,000 hours at full candle-power. The double mount required in the Bernstein lamp presented a difficulty, as it did not admit of so elegant and neat a suspension as in the case of the ordinary lamps. The constant current question, which was a vital one in the case of the series system, was one of extreme difficulty; the constancy had been attempted to be effected by means of an electrical governor, but not with perfect success, as a change in the number of lamps in the circuit produced a perceptible effect upon the others. It was far easier to keep the potential than the current constant. He thought the author's reference to occluded "oxygen" in the filament mounts to be a mistake, as he had heard of occluded hydrogen but not of occluded oxygen; the phenomena observed must therefore be due to some other cause than that suggested. The jumping across which was stated to take place in lamps when others were switched off was a phenomenon which never took place now that lamps were properly made. In conclusion, he expressed his opinion that the light from the large filament was in no respect superior to that from the ordinary fine filament.

Mr. Mortimer Evans explained that the economy of the light from an incandescence lamp greatly depended upon the radiation from the bright surface, and this depended upon the nature of the carbon. He thought that an economy of 2 watts per candle ought to be obtained. A point to be remembered was that with large lamps the electromotive force might be as high as we pleased; the difficulty was to get small lamps with a high electromotive force. Any improvement in brightening lamps must be in the direction of lowering their electromotive force; it was not advisable to raise the temperature.

Mr. Drake agreed with Mr. Crompton as to the difficulty of keeping a constant current; he knew of no regulator which would effect the desired result properly, because it was necessary that a change should take place before the regulation could be effected. He thought that safety appliances absorbed too much power. Resistances were, he considered, very liable to derangement.

Prof. Forbes thought that the shunt difficulty had been solved by Mr. Bernstein, but the expense of the arrangement was, he considered, rather a serious matter, the great saving which would result in the conductors might, however, more than counterbalance this. If it could be proved that the lamps were durable there were many cases in which the series system would be used with great advantage. As regards the constant current difficulty, quite irrespective of compound winding, he would point out that in America the principle had been carried out to a great state of perfection; this was especially the case in the Thomson-Houston system. Weston also had been successful in the matter. One great advantage of the series arrangement was its safety; he affirmed this in spite of what Mr. Crompton and others had said on the subject. No short circuiting could occur as in the parallel system. Earth faults could be avoided by constant testing and cutting off the houses in which earth faults were found; the locality of a fault could be much easier traced in a series than in a parallel system.

Sir David Salomons found that the 50-volt lamps became blacker much sooner than did the 100-volt lamps, a result due to the fact that the area of the glass was smaller in one case than the other. No arcing should take place if the vacuum were good. He had run his installation for 2¼ years without any arcing taking place. He employed the parallel system, and it had given no trouble whatever. He thought that there was a considerable amount of power lost outside the filament itself. Switches ought to be made of china or some other incombustible material.

Prof. Ayrton said that the cost of renewals of lamps was an insignificant item in the total annual expenses, taking the cost of the lamps at 5s. per 1,000 hours. The danger question was much exaggerated; a potential of 2,000 volts would not necessarily kill anyone provided the current were continuous, the danger was from want of continuity; the use of a great number of commutator bars and symmetry of make would avoid this. The constancy of the current in the Thomson-Houston system was obtained by a regulator which moved the brushes. He was inclined to think absolute constancy of potential was the most difficult to obtain. A great point in the low resistance lamp was that in the case of temporary installations a few cells (though possibly of large dimensions) only would be required, the electromotive force required being low. With reference to the use of the word "strain," he thought that "efficiency" much more exactly expressed what was meant.

Prof. Silvanus Thompson considered that a constant current system avoided many difficulties, that of self-induction for instance. It was a curious fact in the Thomson-Houston system that the lamps became perfectly regulated when a number of others were cut out of circuit before the brushes had taken up their final position. The statement that a low resistance lamp was less economical than a high resistance one was, he thought, absurd, as a large hollow filament was nothing more than a bundle of thin filaments joined up in parallel arc.

Col. Webber asked how the platinum of the Bernstein lamp was secured to the glass, and also what was the quality of the latter.

Mr. R. E. Crompton drew attention to a point which appeared to have been overlooked in the question of constant current regulation, and that was, that in the Thomson-Houston system arc lamps were used, which were in themselves regulators.

The discussion was then adjourned.

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NEW PATENTS—1886.

4118. "Incandescent electric lamps." C. SEEL. Dated March 24.

4130. "Counting and recording the number of messages transmitted over telephonic circuits." J. D. MILLER. Dated March 24.

4132. "Dynamo-electric machines." M. BOHDANECKY, J. NESETRIL. Dated March 24.

4133. "Electric arc lamps." H. PIEPER. Dated March 24. (*Complete.*)

4147. "Utilising electric bells for telephonic purposes." E. TUTEUR. Dated March 24.

4162. "Construction and arrangement of electrical conductors mainly applicable to telephonic purposes." W. CHRISTIANI. Dated March 24.

4195. "Soles and heels of boots and shoes, with and without galvanic arrangement, and of socks for same with galvanic arrangement." J. B. WALKER, J. HORROCKS. Dated March 25.

4214. "Electric baths." C. WELLS. Dated March 25.

4230. "Telegraphs." A. M. ROSEBRUGH. Dated March 25.

4231. "Telephones." A. M. ROSEBRUGH. Dated August 15, 1885.

4232. "Telegraphs." J. Y. JOHNSON. (Communicated by A. M. Rosebrugh.) Dated March 25.

4275. "'Morse' or dot and dash printing telegraphs." H. A. C. SAUNDERS, A. C. BROWN. Dated March 26.

4276. "Fire alarm telegraphs." H. A. C. SAUNDERS, A. C. BROWN. Dated March 26.

4280. "Electro-magnetic apparatus to be used for curative and remedial purposes." J. R. CHISLETT. Dated March 26.

4308. "Dental engines operated by electricity." A. KIRBY. Dated March 27.

4324. "Electric lighting." R. C. HANROTT. Dated March 27.

4352. "Voltaic batteries." T. J. JONES. Dated March 27.

4401. "Telephones." E. EDWARDS. (Communicated by E. A. J. Rosoor.) Dated March 29.

4407. "Electric arc lamps." F. THORNTON. Dated March 29.

4412. "Junction or testing boxes for electrical conductors." J. G. LORRAIN. Dated March 29.

4431. "Covered or insulated wires." A. J. BOULT. (Communicated by W. M. Habershaw.) Dated March 30. (*Complete.*)

4453. "Electrical cells or batteries." M. BAILEY, J. WARNER. Dated March 30.

4454. "Arrangement of portable electric light." W. E. MOSER. Dated March 30.

4459. "Constructing incandescent or glow lamps with many filaments in each." R. C. HANROTT. Dated March 30.

CORRESPONDENCE.

Secondary Batteries as Regulators.

With reference to the letter of Sir David Salomons to your journal last week, and the results obtained at Mr. Littleton's installation relative to the question of the conditions under which secondary batteries act most efficiently as regulators, the following explanation has appeared to me the most rational one.

The main reason why secondary batteries act as regulators at all when charged by a shunt machine is, that they tend to maintain a constant strength of field in the dynamo; and with a field maintained constant in this manner, the variation of E.M.F. of the dynamo is only directly proportional to the variation in speed; while in a well constructed shunt machine where the field-magnets depend for their excitation upon both the armature and a varying resistance in the outside circuit, the E.M.F. varies in a more rapid ratio with changes in speed.

Now, so long as current from the dynamo is distributing itself between the secondary batteries and the external circuit, it is obvious that no current can be passing out from the cells; and thus the field of the dynamo is dependent for its strength on a variable resistance, or back E.M.F. of the cells; consequently, the variations in E.M.F. are marked, and pulsations in the light occur.

If, on the other hand, the cells are receiving no current, which means that their resistance (and back E.M.F.) exactly balances the mean E.M.F. of the machine, practically perfect regulation ensues, since they compensate for any shortcomings in the E.M.F. of the dynamo.

As an illustration of the truth of this, anyone who has worked with secondary batteries will recall to mind that a marked pulsation has generally occurred, due to the gas engine, on a given outside circuit if the state of the charge of the cells is low; but as the cells get charged, and their E.M.F. balances that of the dynamo, the pulsations under the same external conditions will cease.

I have seen this change from pulsation to perfect steadiness occur in an instant of time; showing how delicate must be the required balance.

And this brings me to another point that seems to have escaped general notice.

It is not uncommon to find installations put down where accumulators and dynamo have to share between them the outside work; that is, it is hoped that the dynamo and accumulators—each of which are to contribute, say, one-half of the electrical energy required—will obligingly contribute their share without trying to shirk some of it on to the other; whereas the dynamo will not cease to do the whole of the work until such time as the E.M.F. of the cells from one cause or another balances that of the dynamo. Thus the dynamo is generally overworked, unless hand regulation be provided.

This means that we must be content to use secondary batteries simply as regulators, and not attempt to charge them systematically when the outside circuit is switched on, if the conditions of working are with an intermittent speed. Under the above conditions of working, the regulation, *i.e.*, freedom from pulsation and equality of brilliancy under varying loads, will not be affected whether the number of lamps in use is small or large, as Sir David Salomons suggests.

I cannot coincide in the opinion put forward on page 247 that "the proper condition of things required for charging accumulators when the power is supplied by a gas engine or by any prime mover where the delivery of power is in the nature of emphasised intermittent pulsations" is where "the difference of potential falls considerably as the current increases."

It implies a condition of things which in constructing a shunt machine generally is to be avoided; and even in the special case of use in conjunction with secondary batteries it seems to me to mean that if the dynamo is in operation at the same time as the cells on the external circuit, regulation becomes practically impossible.

R. Percy Sellon.

Belvedere Road, S.E.,
March 25th, 1886.

The Bassano Case Digested.

As Mr. Justice North's judgment in the Bassano Telephone Case is very long, I have taken the liberty of extracting therefrom the plums, which I give, as a plain man, in plain language.

(1). The mechanical telephone or lovers' telegraph is as old as the hills; but although some methods of transmitting music by electricity were known, there was no mode known of transmitting articulate speech before Edison's patent of July, 1878. [Edison, therefore, not Reis, nor Gray, nor Bell, is the real original inventor of the speaking telephone.]

(2). This being so, he must be held to have discovered a very remarkable new manufacture and deserves to have his patent stretched beyond its plain meaning.

(3). He has disclaimed everything except the combination of something which he calls a diaphragm or tympan with something else which he calls an electric tension regulator.

(4). He said, it is true, that his diaphragm or tympan must be like a drum, of vellum, metal, horn, or mica; but he also said that there might be one or more diaphragms or tympans at the ends or sides of the instrument, and that they might be of different shapes and

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sizes. Therefore everything that anyone places at the ends or sides of an instrument, whether flexible like mica or not, whether like a drum or not, is a diaphragm or tympan, provided it is of a different size or shape from the drawings.

(5). When you speak to a thin diaphragm it vibrates. When you speak to a thin tube it vibrates. Sir Frederick Bramwell's experiments conclusively prove this. It must not be thought that this proves that the tube was thin. On the contrary, it proves that a tube is a diaphragm or tympan.

(6). Although Edison never said a word about difference of air pressure at the two sides of a diaphragm, everything is a diaphragm when there is a difference of air pressure between the two sides of it. [Everything—from a stick of sealing wax to the solid earth itself.]

(7). The defendants were usually successful with their experiments, the plaintiffs usually unsuccessful. This points to the possibility of further discoveries in the science of experimenting. Nevertheless, judgment is for the plaintiffs.

(8). In some of Edison's tension regulators no carbon is used at all—only soft metals, silk fibre, or platinum; so [although Edison never mentions "carbon" at all] he is entitled to the exclusive use of carbon as a tension regulator.

(9). A billiard ball of ivory when dropped from a height is compressed to half its diameter.

(10). This proves the billiard ball to be elastic and compressible, and therefore, because hard carbon balls will also bounce, this proves them to belong to the same category as silk fibre coated with plumbago, soft metals, mixtures of plumbago with gum rubber, and lamp black.

(11). For Edison to call carbon a semi-conductor is [in spite of the fact that he never used the word carbon and therefore didn't "call" it anything] a fair description. [Note the judicial ideas as to fairness.]

(12). Sir W. Thomson swore that he had seen many forms of Edison's instruments as described in the specification [Query, the silk fibre, or the platinum tubes—or which ?] in practical use, and as defendants' counsel did not cross-examine him on this point, this proves the things described in the specification to be useful forms of instrument.

(13). Because Bassano uses the same kind of hard carbon pencil as are used by Blake, Gower-Bell, Ader and Theiler [all of whom derived them from Hughes's microphone], therefore he is using the substance discovered by Edison to be the best.

I would ask your readers kindly to verify for themselves in the corresponding portions of the judgment of the learned judge the essential accuracy of these dozen plums.

l'Homme Qui Rit.

P.S.—I see that the *Times* reporter has judiciously omitted some of the above plums.—l'H. Q. R.

Secondary Battery Indicators.

No reply having appeared to Mr. Elwell's letter on the above subject in your issue of the 19th March, I venture to say with reference to the suggested difficulty of maintaining the electrolyte at a constant level is not a very difficult matter to ensure within practical limits on the part of the attendant by the ordinary means of filling up the cells with water to the proper mark as it evaporates; but if it is desired to effect it with exactitude automatically, a simple method which I know to have been adopted by Mr. Sellon is to use an inverted flask or vessel which, as occasion requires, is refilled with water and placed with its neck or outlet tube at the level which should be maintained. Displacement, of course, takes place, and compensates for the loss by evaporation or other cause. One of the main objects of employing indicators is to prolong the life of the plates by ensuring proper limits of charge and discharge; it may be well, therefore, to consider the action of the apparatus described by Mr. Elwell relatively with Mr. Sellon's arrangement, described in your edition of March 12th.

In the first case, viz., Mr. Parker's device, which he states is not affected by alteration in the level of the electrolyte. By evaporation of the water the solution becomes higher in density, and, as a result, his apparatus cuts the cells out of the charging circuit before *they are fully charged*, also allowing them to remain in circuit until *they are over-discharged.*

In the second case, supposing no compensation is made as arranged for by Mr. Sellon, the increased density through evaporation, &c., would cause the apparatus to bring the cells into the charging circuit *before they were fully discharged*, also allowing them to remain in circuit until *they were slightly over-charged*, certainly the preferable alternative for keeping the cells in good working order; but, as I have already said, the maintenance of a constant level presents no difficulty, and no such variations need occur.

Henry A. Kent.

March 29th, 1886.

Electric v. Oil Lamps.

From your editorial comments on my letter of the 23rd inst., appearing on page 291 of your issue of the 26th inst., you do not, I fear, grasp my meaning as my remarks will apply in a general sense, whether it be a single lamp purchased or a certain portion of current rented by a consumer.

It is obvious that however cheap electric light may be, it yet costs money, and if it were given *free* to anyone its cost (?) would be then *only one* times less than oil or gas. If, therefore, oil, say, costs £5 for a given period, and electric light *one-and-half* times less, viz., £7 10s. less, it is plain that the balance of £2 10s. is on the other side; or, as I said, the electric light companies or firms would need to pay the purchaser(?) or consumer £2 10s. for taking the electric light. Therefore, if E.L. is to cost one-and-half times less than oil, the apparatus, in whatever form, must be produced for *something less than nothing*. Surely, I imagine I was right when I said that I feared it was a misprint; perhaps *one-and-half* meant *one-half?* If there is another way of elucidating what to me is a mystery I should be happy to hear it.

Arthur E. Cotterell.

Birmingham, *March 29th*, 1886.

The Electric Lamps in the Law Courts.

I enclose a cutting from the *Daily Chronicle* of the 30th inst., which I doubt not has come under your notice. In my humble opinion, when the reporter of an influential paper like the *Chronicle* commits himself to the statement that the electrical engineer of an important installation like the Law Courts informs a judge on the bench that "*a screw passing through the top of the glass*" of an incandescent lamp is "*too fine*" (or too coarse), either the electrical engineer who makes such a statement, or the reporter who reports that such a statement was made, is somewhat short of common sense. Taking it for granted that a man appointed to the post of electrical engineer at the Law Courts knows something about his business, I cannot think he ever made such a statement, consequently, if that is true, either the hearing or intelligence of the reporter must be at fault.

What I would suggest is that our non-scientific papers should, before they launch on the public ear statements of this or any other technical kind, first convince themselves by expert evidence that there is at any rate a possibility of their report being within the range of practical demonstration.

Fair Play.

London, *March 31st*, 1886.

P.S.—If the correspondent of the D. C. is so far at sea in regard to the lighting, what about his accuracy in regard to the rheumatism, bronchitis, catarrh, &c.?

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 437.

INCANDESCENCE LIGHTING.

IN the paper on "Electrical Lighting by means of Low Resistance Glow Lamps," read before the Society of Telegraph Engineers by Mr. Bernstein a fortnight ago, the new term "*strain*" was introduced to describe the condition of an incandescence lamp when, for the expenditure of a certain number of watts we have a certain candle-power. "Strain" is defined by the author as the reciprocal of the number of watts required per candle, and, speaking for ourselves, we can think of no happier term in which to express the relation between candles and watts. According to the new terminology, when the lamp is worked at a high strain, say ·4 candle per watt, its life is short: conversely, when the strain is reduced the life of the lamp is lengthened. In this article we shall in future talk of a strain of ·1, ·2, &c., candles per watt always being understood.

Some of the members present at the meeting to which we refer objected to the new term "strain," and proclaimed in favour of the older term "efficiency," meaning thereby the number of watts expended per candle, but how the term efficiency, as here applied, ever obtained the sanction of scientific authority is a complete puzzle to us. In scientific writing the term efficiency has uniformly the same meaning. It is a ratio, the ratio which one quantity bears to another quantity of the same character; it expresses the fraction received and utilised of the energy given to a system arranged for the transformation of energy and denotes the amount dissipated in such transformation. As applied to incandescence lamps, the term efficiency has no scientific meaning, and we are therefore glad to be able to pronounce in favour of a term which has at least the merit of consistency.

When new terms are sought to be introduced our readers should, before pronouncing a verdict, be careful to distinguish between units whose adoption would be advantageous and helpful and those which may be regarded merely as abnormal developments of a writer's caprice. The rejection of the latter after due consideration forms no argument against the adoption of the former, and the indignant refusal of engineers to revolutionise their accumulated data of half a century in order that some fancied benefit might accrue to electricians can scarcely be regarded with seriousness as an objection to the use of Bernstein's new term.

Passing on to consider some of the points raised in Mr. Bernstein's paper, we notice that objection is taken to the use of high resistance lamps, on account of the existence of minute flaws in the fine filaments. That there are such flaws we can readily believe; that they are more hurtful in fine filament lamps than in those having coarser filaments we are also ready to admit; but it is not only the relative behaviour of different lamps which we have to consider, but the relative values of the present system of parallel working with lamps of 100 volts, and the method proposed by Mr. Bernstein of working a large number of low resistance lamps in series with a potential of 2,000 volts. Disregarding the element of danger which exists in the use of such high potentials, we see only one weak point in Bernstein's method, and that is in the cut-out. We do not say that the cut-out may not work satisfactorily, but we do say that there is too much risk in the system which admits of a number of houses being plunged in darkness consequenton the possible failure of a cut-out to act when it should. The ingenuity exhibited in the construction of the main and lamp switches is doubtless to be admired, but these appear very complicated pieces of apparatus when we consider what they have to do, and how much depends on their successful working. We are inclined to question the wisdom of adopting a system possessing inherent weaknesses of the character specified, and we think its adoption would only be permissible if the line were duplexed. In this case a double cable would run all round the circuit half the lamps in every house being lit from each. It is extremely improbable that a breakdown would occur on both lines at the same time, and with this arrangement the liability to failure is enormously reduced.

Mr. Bernstein does not give in his paper any data respecting the life of his lamps. This is unfortunate, as, from our experience, reliable data connecting the strain with the life of the lamp are exceedingly difficult to obtain. It appears that the ideas of the makers regarding the strain that ought to be put on a lamp consistent with durability have undergone lately considerable modification, for now we find that instead of increasing the strain, as was the tendency some time ago, it is being gradually diminished. One manufacturing firm informs us that lamps taking 4 watts per candle corresponding to a strain of ·25 are preferred by their customers on account of their greater durability, and that their experience leads them to recommend this strain, remarking as a matter of course that the lamps made by other makers, and having a greater strain are unreliable. By another manufacturing firm we are informed that there is an element of weakness in the filaments of high-resistance lamps which conduces to shortness of life if they are worked at a high strain. To last 1,000 hours they recommend that the strain do not exceed ·25, for with a strain of ·28 the lamp will lose fully 20 per cent. of its light in that time. The Edison-Swan Company's 16 candle-power lamp takes 0·6 ampère and 100 volts, and has therefore a strain of ·2$\dot{6}$, but it is very doubtful if with this strain it will last 1,000 hours. The low-resistance lamp exhibited by Mr. Bernstein took a current of 9·75 ampères at a potential of 7 volts to give 20 candle-power which corresponds to a strain of ·29, and here, also, great duration is extremely improbable. It is significant that in no case will makers, as far as we know, recommend lamps taking 2½ to 3 watts per candle, or strained to ·4 and ·$\dot{3}$ respectively if duration

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is to be considered. It is still more significant that in no case will they guarantee any duration whatever.

We do not say that lamps should last 1,000 hours or even 500 hours. We know that the life of the lamp is in some way related to the strain put on it, and the lamp to give maximum economy, as regards the annual cost of power and renewals, must be strained to a different degree under different circumstances. But before we can determine the strain which it is most economical to give to a lamp, and by which the total annual cost shall be a minimum, it is necessary that we have clearly established the relation between the life of a lamp and the strain to which it is subjected. Several duration tests have been made from time to time, and in investigating the subject we have been compelled to collect evidence from every available source, giving due prominence to tests of most recent date. Taking them as a mean for all kinds of lamps it appears that the figures given below represent with fair accuracy the relation between the strain and the duration—

Strain.		Duration.
·1 candle per watt	... ...	4,000 hours.
·2 „	... ...	1,000 „
·3 „	... ...	500 „
·4 „	... ...	250 „

We do not say that the figures given are absolutely correct, but we believe them to be fairly accurate. Taking them as a basis for further investigation, two problems of interest present themselves for solution. The first problem is, at what "strain" should lamps be worked to obtain minimum annual expenditure when the power is supplied by a gas engine burning London gas at 3s. per thousand cubic feet? The second problem to be solved is, what must be the strain to obtain maximum economy when the power is supplied by a factory engine, the power for the lights being so small relatively to the total power given out that the interest on the motor supplying it may be in our calculations neglected? To the solution of these two problems we shall address ourselves in a future issue, but for the present we leave the subject, our readers having now been informed of the basis on which we shall proceed.

MAGNETIC SCREENS.

THE statement often met with that masses of soft iron will screen a magnet or other body from the effects of external magnetism, says Prof. W. A. Anthony in the *Electrical World*, seems not to be well understood. The effect is best explained by studying the "lines of force" by means of which Faraday so clearly expressed the effects of the magnetic field. The directions of these lines may be well shown by sprinkling iron filings on a piece of glass laid over a magnet. The curves so obtained are represented in fig. 1.

But the intensity as well as the direction of the forces in the magnetic field may be indicated by so drawing the lines that the number passing through unit area at any place shall be equal to the intensity of the field at that place, as indicated.

Where lines are close together the force is strong; where they are far apart the force is weak. In one respect, however, this diagram, which is similar to those generally given in the text books, is faulty. No line of force really ends in the space around the magnet, but is continuous from pole to pole, and, since the lines may be considered as returning to their starting points through the bar, each is a closed curve extending from the north to the south pole through the magnetic field and back to the north pole through the magnet.

It is well known that a wire carrying an electric current exhibits magnetic force. The lines of force around such a wire are circles whose centres are on the wire, and whose planes are perpendicular to it. Let the wire be wound into a helix, and these circular lines surrounding the individual spires combine to produce lines of force exactly similar to those of a bar magnet, and the helix *is* a magnet, possessing all the properties of a magnetised bar. If a bar of soft iron be put into the helix the magnetic force is greatly increased; or, in other words, the lines of force become more numerous. This is usually explained by saying that the bar is magnetised by the current and adds its force to that of the helix. But there is another way of viewing this magnetic effect of the helix, that aids greatly in understanding certain magnetic phenomena. The tendency of the helix to develop magnetic lines may be called "magneto motive force," and compared to the E.M.F. of a voltaic cell. The material in the space within and around the helix may be considered as offering more or less resistance to the formation of magnetic lines, and the number of lines formed in any case will depend upon the relation that the magnetomotive force bears to this resistance, just as the electric current produced in a given case depends upon the relation of the E.M.F. of the generator to the resistance of the circuit. Upon this view, the increased effect when iron is placed in the helix is due to the fact that iron is a far better conductor of magnetic lines than air.

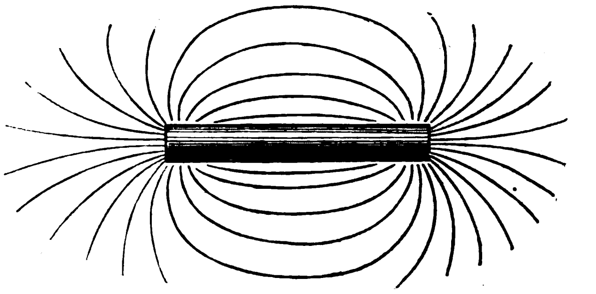

FIG. 1.

Let us apply this idea to the study of the screening effect of masses of soft iron. Suppose a soft iron ring, fig. 2, to be placed in a magnetic field. In consequence of its high conductivity the lines of force entering it on one side will follow round the ring and escape from it on the opposite side, leaving the interior almost devoid of magnetic force. But, if a plate of iron be similarly placed in a magnetic field, so far from screening the space beyond it, it will, unless it is very large, rather increase the strength of the field. Fig. 2 represents approximately the appearance of the lines of force in these two cases.

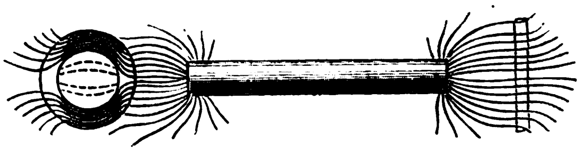

FIG. 2.

It is, therefore, not sufficient to interpose a mass of iron, unless a very large one, between a magnet and the body to be screened from its effects. To be effectual, the screen must completely surround the body, or else surround the magnet. The writer has recently tested a device for shielding watches from the effects of a magnetic field, in which this principle is applied. The shield consists of a little sheet iron pan in which the works are placed and covered with a sheet iron disc placed under the dial. It proved a perfect protection when the watch was placed edgewise within three-fourths of an inch of a large and very powerful electromagnet. When the watch was back toward the magnet the protection was not so perfect, but was effectual in a magnetic field to which the watch would not be likely to be exposed by being worn around a dynamo.

Some familiar magnetic phenomena appear in a clearer light when the office of masses of iron is considered to be that of conductors of magnetic lines of force. For instance, when an armature is applied to a horse-shoe magnet, a good conductor of magnetic lines

is substituted for the air, a poor conductor, through which the lines, comparatively few in number, go straying round from pole to pole. The result is that, if the armature is massive enough, nearly all the lines go through it and the external field almost entirely disappears. A good analogy would be found in a voltaic battery submerged in a poorly conducting liquid. The electric current would go from pole to pole, spreading out through the liquid something as the lines of force go through the air from pole to pole of a magnet. But, if the poles of the battery be joined by a thick copper wire, the current will flow through it, and will almost disappear from the liquid. Besides this the total current is largely increased when the copper wire connects the poles, and in like manner the magnetic lines are increased when iron is substituted for air in the magnetic circuit.

In the dynamo machine it is the office of the field-magnets to develop a field in which the armature is to revolve. The masses of iron in the field-magnets and armature should be so proportioned and so placed, that the lines of force going from pole to pole shall, as far as possible, go through the armature, and not through the air outside. Magnetism outside the machine is magnetism wasted, and any considerable outside field is evidence of faulty construction. Such a defect is often due to too little iron in the armature, or too small or too long a connecting piece between the parts of the field-magnet, or sharp points or angles about the pole pieces.

PROF. HUGHES AND SELF-INDUCTION.*

CRITICAL REMARKS ON THE DISCOVERIES OF MR. HUGHES REGARDING SELF-INDUCTION IN METALLIC CONDUCTORS.

By Prof. H. F. WEBER.

PROF. D. E. HUGHES, in his inaugural address as newly-elected President of the Society of Telegraph-Engineers and Electricians (January 28th, 1886), gave a detailed account of a series of investigations, with which he has lately been occupied, concerning the influence of the nature and the form of metallic conductors upon their self-induction.†

The said investigations led Mr. Hughes to new and most remarkable results, which must needs excite considerable interest in the world of science; for, supposing these results to be indeed reliable, they would be at variance with the electro-dynamical theories of the present day, and would necessitate a thorough reform of the last.

It suffices to consider but two of the results of Mr. Hughes's researches, which must, without doubt, be regarded by every competent reader as the most important in the whole work.

Hitherto, for non-magnetisable metallic conductors, the coefficient of self-induction has been regarded as a quantity whose value depends exclusively upon the form and the geometrical dimensions of the conductor, having absolutely no relation to the material of the same. Only for magnetisable wires electro-dynamics accepted an influence exerted by the material upon the said coefficient. These wires acquire a circular magnetisation by currents passing along their axes. This circular magnetisation produces a considerable augmentation of the coefficient of self-induction, just as an iron core of a coil produces an immense growth of the coefficient of self-induction of the latter.

Mr. Hughes has arrived at results widely differing from this. He finds the coefficient of induction of *every* metallic conductor to be dependent upon the material nature of the conductor, and *variable with the same in a most decided manner.* Mr. Hughes's measurements give us in the following numbers the relative values of the coefficient of induction of straight wires of 1 mm. diameter and 30 cm. length for the various metals :—

Soft Swedish iron ...	100	Copper	20
Soft puddled iron ...	88	Brass	13
Swedish iron not softened	55	Zinc	12
Soft cast steel	41	Lead	10
Nickel	34	German silver	7
Hardened cast steel ...	28	Mercury	2
Cobalt	24	Carbon	1

The relation of the coefficient of self-induction to the form and dimensions of the conductor has long since been formally developed for the general case. From the general form may be deduced that the coefficient of self-induction of a long thin straight wire with a circular constant section may be expressed by

$$Q = 2\,l \left\{ \log. \left(\frac{2\,l}{\rho} \right) - 0{\cdot}75 \right\}$$

l being the length, ρ the radius of the wire.

Should the wire be of a magnetisable material, and the growth of the magnetic moment be proportional to that of the magnetising force, then the coefficient of self-induction receives a slightly different form, namely :

$$Q = 2\,l \left\{ \log. \left(\frac{2\,l}{\rho} \right) - 0{\cdot}75 + \pi . \kappa \right\}$$

κ being the constant of magnetisation.

According to these principles the coefficient of induction of such wires of constant length diminishes logarithmically with the growing thickness of the wire.

On these relations of the induction coefficient of straight wires to the thickness of the same, Mr. Hughes has made numerous determinations. His experiments gave him the general result, that the coefficient of self-induction of thin straight metallic wires depends in such a manner upon their thickness that this quantity receives the smallest value for the thinnest wire, then, growing with the thickness, becomes for a certain diameter a maximum, falling from that point by further growth of the wire in a continuous manner. For the better comprehension of this peculiar connection between the thickness and the induction coefficient of a wire, the following table gives three examples, as was found for soft iron, copper, and brass for wire diameters of :

	mm. 0·1	mm. 0·25	mm. 1·0	mm. 2·0	mm. 3·0	mm. 4·0	mm. 5·0	mm. 6·0	mm. 7·0	mm. 8·0	mm. 9·0	mm. 10·0
Iron ...	28	80	100	93	85	72	57	47	42	38	33	30
Copper	12	14	20	23	27	28	25	22	20	18	16	11
Brass	6	8	13	20	23	25	27	27	25	22	20	16

This rise and fall of the induction coefficient with the growth of the wire thickness so unexceptionally observed, and the considerable variance of the course taken by this phenomenon from metal to metal, form other serious contradictions between the measurements of Mr. Hughes and the views hitherto in vogue in electro-dynamics.

These contradictions just pointed out demand a critical investigation of the question as to which side is at fault.

The following lines have been written with the view to explain that the causes of the said contradictions lie in an incorrect interpretation given by Mr. Hughes to his measurements and that these contradictions are perfectly annulled by a correct interpretation of the data of his experiments.

Mr. Hughes employed the Wheatstone bridge. The straight piece of wire of which the coefficient of self-induction was to be measured formed the one side of the Wheatstone quadrangle, the remaining three sides consisting of a single homogeneous thin wire of German silver, bearing at two points, C and D, sliding contacts. In the one diagonal of the quadrangle, A C, was introduced the mechanism for producing an oscillating current and a first cylindrical coil, S_1. The other diagonal, B D, was led through a telephone and a

* Communicated by the Author.

† This inaugural address is to be found *in extenso* in the ELECTRICAL REVIEW, Vol. XVIII., p. 126—130.

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second, smaller cylindrical coil, S_2, concentrically placed to S_1, the axes, however, forming an angle, u, which could be enlarged or diminished at will.

In measuring the coefficient of induction of the piece of wire, A B, the contacts, C and D, were so placed and the angle, u, of the axes of the two coils chosen in such a manner, that there was silence in the telephone. *Mr. Hughes believed that the angle, v, which complements this angle, u, to 90°, to be an exact measure for the coefficient of the electromotive force of the extra current and, as such, for the coefficient of self-induction of the conductor*, A B. He therefore only measured this angle; the relative values he gives for the coefficients of self-induction of the various conductors are the values of this measured angle, v.

This assumption is, however, perfectly incorrect, as may be deduced from the following remarks.

We will suppose that the variable intensities of current in the six lines

A C A B B C A D C D and B C

are at the time t

$$i_0 \quad i_1 \quad i_2 \quad i_3 \quad i_4 \text{ and } i$$

and that the resistances and coefficients of self-induction of these six lines are

$$w_0 \quad w_1 \quad w_2 \quad w_3 \quad v_4 \text{ and } w$$

and

$$Q_0 \quad Q_1 \quad Q_2 \quad Q_3 \quad Q_4 \text{ and } Q.$$

We will call P the mutual potential of the two coils, S_1 and S_2, and assume the electromotive force, ϵ, which excites the oscillating current in A C to be any periodical function of the same, that is, mathematically expressed, of the form

$$\epsilon = {}_h\sum_1^m \epsilon_h \,.\, \cos.\,(h\,n\,t + \omega_h)$$

h being any integer number $1, 2 \ldots h \ldots m$, and ϵ_h and also ω_h being constant quantities, dependent upon the nature of the induction apparatus in use, and n standing for the value $\frac{2\pi}{T}$ (T = period of the oscillation).

If we assume further that only the two coils, S_1 and S_2, exert a mutual induction in comparison to which the effects of mutual induction between the other parts of the net of conductors may be neglected, we shall be able to arrive at the six variable intensities of current by means of the following six equations:

$$i_0 w_0 + i_1 w_1 + i_2 w_2 + Q_0 \frac{di_0}{dt} + Q_1 \frac{di_1}{dt} + Q_2 \frac{di_2}{dt} + P \frac{di}{dt} = \epsilon$$

$$i_3 w_3 + i\,w - i_1 w_1 + Q_3 \frac{di_3}{dt} + Q \frac{di}{dt} - Q_1 \frac{di_1}{dt} + P \frac{di_0}{dt} = 0$$

$$i_4 w_4 - i_2 w_2 - i\,w + Q_4 \frac{di_4}{dt} - Q_2 \frac{di_2}{dt} - Q \frac{di}{dt} - P \frac{di_0}{dt} = 0$$

$$i_0 = i_3 + i_1 \quad | \quad i_3 = i_4 + i \quad | \quad i_0 = i_4 + i_2$$

As an expression for the intensity of the current in the bridge we find:

$$i = {}_h\sum_1^m \epsilon_h \,.\, \sqrt{\frac{\alpha_h^2 + \beta_h^2}{\gamma_h^2 + \delta_h^2}} \,.\, \cos.\,(h\,n\,t + \omega_h + \psi_h)$$

in which

$$\tan.\,\psi_h = \frac{\beta_h \gamma_h - \alpha_h \delta_h}{\alpha_h \gamma_h + \beta_h \delta_h}$$

and

$$\alpha_h = w_1 w_4 - w_2 w_3 - h^2 n^2 \{Q_1 Q_4 - Q_2 Q_3 - P(Q_1 + Q_2 + Q_3 + Q_4)\}$$

$$\beta'_h = h\,n\,\{Q_1 w_4 - Q_3 w_2 + Q_4 w_1 - Q_2 w_3 - P(w_1 + w_2 + w_3 + w_4)\}$$

It is scarcely necessary to give here the long explicit forms for γ_h and δ_h, seeing they are not required in the development of the value of the coefficient of self-induction Q_1 of the conductor, A B.

The current in the bridge is constantly zero if $\sqrt{\alpha_h^2 + \beta_h^2}$ is $= 0$ for every value of h. This is not possible in general; it is, however, the case for the special conditions realised in Mr. Hughes's experiments in which Q_1, Q_2, Q_3, Q_4 and P had absolute values lying about 400 to 1,000, n running from 20π to 200π; the resistances, w_1, w_2, w_3, w_4, however, were approximately of the order 10^7 to 10^9. In consideration of this, the quantity

$$h^2 n^2 [Q_1 Q_4 - Q_2 Q_3 - P(Q_1 + Q_2 + Q_3 + Q_4)]$$

may, for Mr. Hughes's measurements, be neglected as very small compared to the products of resistances, $w_1 w_4$ and $w_2 w_3$. This is all the more allowable as the following equation of condition (2) reduces the expression

$$Q_1 Q_4 - Q_2 Q_3 - P(Q_1 + Q_2 + Q_3 + Q_4)$$

to a low value.

In Mr. Hughes's experiments, therefore, the bridge current was constantly annulled when

$$0 = w_1 w_4 - w_2 w_3 \qquad (1)$$

and

$$0 = Q_1 w_4 - Q_3 w_2 + Q_4 w_1 - Q_2 w_3 - P(w_1 + w_2 + w_3 + w_4) \qquad (2)$$

had been attained by a proper adjustment of the contacts C and D, and by a sufficient enlargement or diminishment of P by turning the interior coil, S_2, upon its axle.

These two equations render us the value of Q_1, the coefficient of self-induction of the wire, A B, in the following form:

$$Q_1 = P + \left(\frac{P}{w_4} + \frac{P}{w_3} + \frac{P}{w_2}\right) w_1 + \left(\frac{Q_3}{w_3} - \frac{Q_4}{w_4} + \frac{Q_2}{w_2}\right) w_1 \qquad (3)$$

This expression may be somewhat transformed. Supposing, firstly, the middle radius, ρ_2, of the interior coil to be considerably smaller than that of the exterior coil, ρ_1, the mutual potential, P, of the two coils may with great approximation be given by the form

$$P = 2\pi^2 \,.\, n_1 \,.\, n_2 \,.\, \frac{\rho_2^2}{\rho_1} \,.\, \sin.\, v$$

(n_1 and n_2 expressing the numbers of windings on the coils), or for small values of v by

$$P = 2\pi^2 \,.\, n_1 \,.\, n_2 \,.\, \frac{\rho_2^2}{\rho_1} \,.\, v = P_1 \,.\, v,$$

in which P_1 is the short signification for the constant of the apparatus.

Further notice should be taken of the fact that in Mr. Hughes's measurements the conducting line leading from B through C and D back to A consisted in all cases of a homogeneous thin German silver wire with the same thickness.

If we call the lengths B C, C D, D A of this wire l_2, l_3, l_4 and ρ the radius of the same, we may, therefore, note the following equations:

$$w_2 : w_3 : w_4 = l_2 : l_3 : l_4,$$

and

$$Q_2 = 2\,l_2 \left\{\log.\left(\frac{2\,l_2}{\rho}\right) - 0{\cdot}75\right\}$$

$$Q_3 = 2\,l_3 \left\{\log.\left(\frac{2\,l_3}{\rho}\right) - 0{\cdot}75\right\}$$

$$Q_4 = 2\,l_4 \left\{\log.\left(\frac{2\,l_4}{\rho}\right) - 0{\cdot}75\right\}$$

These equations permit of writing the third summand on the right-hand side of equation (3), as

$$\left[\frac{Q_2}{w_2} + \frac{2\,l_3}{w_3} \log.\left(\frac{l_3}{l_4}\right)\right] \,.\, w_1,$$

and by introducing this in equation (3) we arrive finally at the following expression for the quantity to be determined:

$$Q_1 = P_1 \,.\, v + \left\{P_1 \,.\, v\left(\frac{1}{w_4} + \frac{1}{w_3} + \frac{1}{w_2}\right) + \frac{Q_2}{w_2} + \frac{2\,l_3}{w_3} \log.\left(\frac{l_3}{l_4}\right)\right\} \,.\, w_1 \qquad (4)$$

This expression once given, it is easy to say what

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mistake Mr. Hughes made in the interpretation he gave to the data of his measurements: *he simply assumed the coefficient of self-induction*, Q_1, *to be proportional to the angle*, v, *whereas, as lies in the nature of his method, the quantity*

$$\left[P_1 \cdot v\left(\frac{1}{w_4}+\frac{1}{w_3}+\frac{1}{w_2}\right)+\frac{Q_2}{w_2}+\frac{2\,l_3}{w_3}\log.\left(\frac{l_3}{l_4}\right)\right]\cdot w_1$$

must be added to the quantity, $P_1 \cdot v$.

This additional value, however, is proportional to the resistance, w_1, *of the conductor, of which the coefficient of self-induction is to be measured.*

This circumstance enables us at once to understand why Mr. Hughes was bound to arrive at the remarkable results we described at the beginning of this paper. From the fact of his assuming Q_1 to be simply proportional to v it followed that he constantly found a too small value for the said quantity; but the additional value varying with the size of the resistance, w_1, the mistake made was very different in different cases. In the series of observations which Mr. Hughes made to obtain the coefficients of induction of various conductors of like form and the same dimensions, but with different specific resistances, he was compelled to find those of conductors of greater specific resistance to have much lower values than those of conductors of a small specific resistance. And such was indeed the case, for Mr. Hughes gives us the relative valves of Q_1 for non-magnetisable metals as

Copper ...	20	German silver	7
Brass ...	12	Mercury ...	2
Zinc	12	Carbon ...	1
Lead	10		

It is further clear how Mr. Hughes, in examining the induction coefficient for conductors of the same metal and the same length, but of varying thicknesses, came across the remarkable rise and fall of this quantity, previously treated of and enlightened by numeric examples.

For every thickness of wire Mr. Hughes's assumption naturally gave a too small value for Q_1; but the factor w_1 of the additional term being for the same metal and for a constant length of wire inversely proportional to the square of the diameter, the fault made was for very thin wires much greater than for such of a more considerable radius. This circumstance explains qualitatively in the simplest way the rise and consequent fall of the coefficient of self-induction as determined by Mr. Hughes.

In order to obtain correct values for the induction coefficients the remainder of Mr. Hughes's measurements will have to be treated in the same manner: all the numbers given in Mr. Hughes's paper are not expressions for Q_1, but only expressions for the complex of quantities

$$Q_1 - \left\{P_1 \cdot v\left(\frac{1}{w_4}+\frac{1}{w_3}+\frac{1}{w_2}\right)+\frac{Q_2}{w_2}+\frac{2\,l_3}{w_3}\log.\left(\frac{l_3}{l_4}\right)\right\}\cdot w_1$$

or of

$$Q_1 - \left\{P_1 \cdot v\left(\frac{1}{l_4}+\frac{1}{l_3}+\frac{1}{l_2}\right)+\frac{Q_2}{l_2}+2\log.\left(\frac{l_3}{l_4}\right)\right\}\frac{w_1 \cdot q}{\omega}$$

if q and ω denote the section and specific resistance of the wire B C D A in use. This last formula makes it evident that the mistake made by Mr. Hughes would have been about a hundred times greater had he employed in his experiments in place of the German silver wire of 0·25 mm. diameter a copper wire of 1 mm. thickness. A change of wire would therefore have produced an immense difference in the whole of the results.

It may be that Mr. Hughes has noted in the register of his experiments besides the angles v all the data necessary for determining the seven values w_4, w_3, w_2, w_1, l_3, l_4 and Q_2. Should this be so, he would be able to convince himself, by introducing these values into the formula above given for the calculation of Q_1, of the facts that—

1. The coefficients of self-induction of the non-magnetisable metals are perfectly independent of their material nature, and that—

2. The coefficient of self-induction of a straight, non-magnetisable wire of circular section depends in such a manner upon the length, l, and the radius, ρ, as is expressed by the formula

$$Q_1 = 2\,l\left\{\log.\left(\frac{2\,l}{\rho}\right) - 0{\cdot}75\right\}$$

That this expectation should indeed become realised I am entitled to believe by the results of some series of measurements carried out lately by myself, employing Mr. Hughes's method in determining the coefficients of self-induction of three wires, namely—

Of a copper wire of 200·0 cm. length and 0·050 cm. radius,

Of a German silver wire of 200·0 cm. length and 0·050 cm. radius,

And of a thread of mercury of 200·2 cm. length and 0·051 cm. radius.

Calculating from the data of my measurements the coefficients of induction for these conductors by means of the previously-developed formula, I was not able to discover with certainty the slightest difference between them.

All these new results, therefore, which Mr. Hughes has brought to light, must be regarded as products of an incorrect interpretation.

Electrical Laboratory of the Polytechnikum,
Zürich, *March 25th*, 1886.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XVI.

WERE it possible to construct electro-motors of small weight and limited dimensions, which would work efficiently at a speed of from 70 to 100 revolutions per minute, then we should get an exceedingly simple apparatus for actuating the driving axles of a vehicle. The driving axles would thus be the armature shafts, and two bearings to support the field magnets would complete the propelling mechanism. Unfortunately, it is impossible to construct motors of such small speed, giving the requisite power and efficiency, therefore it becomes a necessity to interpose between the armature spindle and the driving axle some mechanical gearing, which will give the suitable velocity ratio. If the car wheels are of a circumference which will traverse six miles in an hour when rolling at the rate of 80 revolutions per minute, and if the motor has to make 960 revolutions during the same period, then the velocity ratio is as 1 to 12. It would seem that there is nothing easier than to transmit motion at the above-named velocity ratio; numerous well known mechanical appliances will at once suggest themselves to the mind, and the only difficulty that may seem to trouble the mechanician is that of space,—the lack of space. After the question of space is settled, however, and some fruitless attempts have been made to reduce 960 revolutions of one shaft to 80 of another, then he discovers that there are few well-known elements of mechanism which will satisfy the peculiar conditions of this case. It is hard to arrange the points of merit or the conditions to be satisfied in their respective order; they all appear to be of equal consequence, and we will name them promiscuously. These are for tramcar propulsion: Efficiency, durability, simplicity, absence of noise and vibration, certainty of action, cheapness, and small weight. Protection from dirt may be obtained by careful casing in.

Countershafts, or intermediate wheels will be found requisite in almost every kind of gearing except worm gearing, there being too little room to work with one pair of wheels or pullies. Straps and pullies, with countershaft, offer all the above merits with the exception of certainty of action; straps will stretch and

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also slip under certain conditions, no matter how tightly they may be placed upon the pulleys, or kept taut by means of stretching rollers; when we have to deal with sharp curves and inclines the strap and pulley mechanism cannot be relied upon; the same drawback will be found with ropes and substitutes of same. Gearing chains working in toothed wheels are more reliable, they cannot slip, and this method of transmitting motion on electric cars has been largely adopted; chains, however, cause some noise and vibration, and they require a considerable amount of attention; when once they stretch in the least degree the links will tend to ride over a tooth and cause breakage. The friction of chain gearing is by no means small, the radius of the first motion wheel which is attached to the motor spindle is necessarily very limited, therefore the twisting moment variable and the motion somewhat irregular, nor does the bending and unbending of the link joints reduce the efficiency so much as the centrifugal force tending to throw the heavy chain tangentially off the wheel; the cost of carefully constructed chains and wheels is considerable. For a study of this subject the researches of Professor Keller ("Zeitschrift des Oesterreichischen Ingenieur Vereins, 1878") will be found highly interesting; the best proportions of links and the most efficient forms of teeth for chain gearing are given in that communication.

Toothed wheel gearing, for the first motion couple, at any rate, has been abandoned by all who ever attempted to use it for high-speed machinery; the noise and wear and tear is excessive, therefore out of the question for tramcar propulsion; even with the second motion shaft it is doubtful whether the noise and vibration will not be considered too great for the comfort of persons inside and outside a vehicle. The most careful design, perfect tooling, and special materials are of no avail in pinions of small diameter running at more than 800 revolutions a minute.

Friction gear offers the advantage of simplicity, noiselessness, and efficiency, but with regard to certainty of action and durability, it occupies not the first rank. It is difficult to transmit much power through friction rollers without slipping. Although friction gear has been most successfully applied to the driving of dynamo machines (by Messrs. Siemens and Mr. Raworth), where the flywheel of the steam engine turns the pulley of the dynamo, a moderate amount of pressure between the two insuring perfect uniformity of motion, yet when the order of things was reversed, and the dynamo had to drive the wheel of a locomotive, for instance, friction gear did not appear to answer so well. When driving a dynamo we start without a great load, and when once the comparatively small inertia of the armature is overcome, and with a constant speed afterwards, such gearing answers admirably. If, however, the small friction pulley has to drive a large wheel to which a great weight is attached then the liability to slipping comes in, and very great pressure is needed so that, with the small leverage offered by the tiny pulley on the armature shaft, the requisite starting effect may be produced.

The "nest" gearing, devised by the late Professor Jenkin for the telpher locomotive, may be considered as the most perfect frictional gear ever invented, but it does not seem to have answered the expectations of the inventor, for it has been abandoned on the telpher line at Glynde. With a pair of friction wheels, running together like a pair of rolls, the contact surfaces are so small that the pressure per unit of surface must be large, and therefore the destruction of the same rapid.

When the centre of one wheel is within the diameter of the other of a pair, then the surfaces in contact are appreciably larger, and the destructive effect of the transmission of motion by frictional adhesion becomes correspondingly smaller; thus Professor Jenkin placed several rollers within the driven wheel or ring, and thereby multiplied the surfaces of contact. The results of continued work with this kind of gearing have not been published, and we are unable to judge of the practical merits of this invention.

There is another kind of friction gearing, often called "wedge gearing," which has found many applications for hoists; the circumferences of the wheels in this have wedge-shaped projections, formed by circumferential grooves, so that the projecting rings of one wheel fit into the grooves of the other, whereby motion can be transmitted with a moderate pressure. As in the former case, the contact surfaces are small, and at high velocities the wear is considerable; the coefficient of friction has to be kept at a high point for the purpose of adhesion, consequently the efficiency is rather low. The efficiency of the system will vary with the coefficient of friction and the pressure between the wheels; and if we wish to transmit much power, both these factors will have to be appreciable quantities. Writing α for the angle of the wedge-shaped contact rings, R the pressure, μ the coefficient of friction, we obtain the efficiency

$$\eta = \frac{\mu \text{R}}{\sin. \frac{\alpha}{2} + \mu \cos. \frac{\alpha}{2}}$$

if α is 30°, as would be the case according to the assumed best form, then the efficiency with ·2 for a coefficient of friction

$$\eta = \frac{\cdot 2 \text{ R}}{\sin. 15^\circ + \cdot 2 \cos. 15^\circ} = \cdot 43 \text{ R}.$$

Worm gearing has been much abused, and comparatively little attention has been given to the study and construction of this mechanism. With a rational design, excellent workmanship, careful selection of materials, and, above all, perfect lubrication, the efficiency of worm gearing can be rendered double that usually assigned to it by writers of old-fashioned text-books. Thanks to the researches of Prof. Thurston, Prof. Kimball, Mr. Beauchamp Tower, Prof. Hele Shaw, and others, the laws of friction have been entirely remodelled, in fact, all the long-established laws have been completely upset. Mr. Tower has most conclusively demonstrated that the coefficient of friction for lubricated bearings is not ·1 to ·2, as so frequently stated in text-books, but ·003 and less, and that even with moderately bad lubrication the coefficient could not be increased to much above $\frac{1}{100}$. In order that worm gearing may work efficiently, the thrust bearing must be thoroughly lubricated, and the worm, or the worm wheel, run in an oil bath, dirt being excluded by a protecting casing. Clean and well-fitting bearing surfaces, together with multiple threads, so as to render the angle of the teeth proportionately large, will furnish a durable, efficient, reliable and silent mode of transmission, such as we require for tramcar propulsion. The efficiency of worm and wheel is given by the following formulæ, where θ is the angle of the worm thread, μ the coefficient of friction, r the radius of the worm, and p the axial pitch of the worm, φ the angle of repose of metal on metal, then the efficiency of the pair is

$$\eta = \frac{\cot. \theta}{\cot. (\theta - \varphi)} = \frac{1 - \mu \frac{p}{2 \pi r}}{1 + \mu \frac{2 \pi r}{p}}$$

Taking $\mu = \cdot 15$ as usually given in text-books; p, for example, $1\frac{3}{8}$ inches and r $1\frac{3}{4}$ inches, then the efficiency would be 44·6 per cent. only; whereas with a coefficient of friction of ·015, the efficiency comes out as 89 per cent. The results of the author's experiments point to an efficiency of about 85 per cent. at the normal working speed; at higher velocities it is greater, at low velocities less, the coefficient of friction varying with the speed. Much might be said on the subject of friction at high velocities, but not without drifting far beyond the sphere of these essays on Electric Locomotion.

The Coefficient of Friction.—In support of Mr. Reckenzaun's statement regarding the coefficient of friction varying with the speed, we may mention that the late Sir Charles Wheatstone many years ago constructed an apparatus specially to prove this fact.

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MINIMUM WASTE AND MAXIMUM ECONOMY.

By Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S.

WE are all of us much indebted to Sir William Thomson for his remarkable paper given at the meeting of the British Association in 1881, since it possessed a double value. First it directed the attention of electrical engineers to the importance of determining the conditions of maximum economy when we had a choice of expenditure in two directions of such a nature that increasing the one expenditure diminished the other, for example, it was this paper of Sir William Thomson's that suggested to us the method that we published about a year ago for determining what was the most economical potential difference to use with a certain type of incandescent lamps. Secondly, this paper of Sir William Thomson's showed people how to determine the most economical gauge to give to a wire when we knew the current, the yearly value of a horse-power, the value of copper and the rate of interest on money. But what we have desired to point out in our paper on "Economy in Electrical Conductors," recently published in the ELECTRICAL REVIEW, is that, although his rule is perfectly correct mathematically, it cannot generally be used to determine the conditions of maximum economy, because some electrical condition, either in addition to the strength of the current, or in place of the strength of the current, is given us. Indeed, in the application made by Sir William Thomson of his own rule in his inaugural address he *starts* by assuming that we know the potential difference at the dynamo end of the line, which he takes as 80,000 volts. He next says let us employ a solid copper wire half-an-inch in diameter, &c.

To obtain the most economical current he uses his rule

$$C = \frac{t}{r},$$

and as 48·85 is the value he takes for t, and 0·2035 ohms the value he takes for r, the resistance per mile of his conductor, half-an-inch in diameter, he concludes that the proper value to give to C is 240 ampères.

But we deferentially submit that this is incorrect, because, as we pointed out, his rule has been obtained by finding the value of r that makes the total waste per mile

$$C^2 r + \frac{t^2}{r}$$

a minimum when C is constant and r a variable, and it cannot, therefore, be used to find the value of C when r is fixed and C is the variable, which are the conditions of Sir William's Niagara problem as he has stated it. In fact, if we regard r as constant, and C as the variable, the value of C that makes the expression for the total waste per mile a minimum, is C equal to nought. And it is perfectly true that C equal to nought leads, in this case, *to minimum waste, but not, of course, to maximum economy*. In fact, when C alone is the variable a consideration of the waste does not lead to a practicable answer, and, consequently, with the conditions that Sir William Thomson has taken with the Niagara problem a method of procedure different from the one that he has adopted must be followed in order to determine the value of C that should be used to obtain maximum economy.

In the problem solved in our paper we have considered that the power given out at the other end of the line was fixed, but as this is not one of the conditions of the Niagara problem the method followed in this paper cannot be employed either in this case. Probably the simplest way of attacking the Niagara problem is to determine the value of C that makes the *efficiency a maximum*. This may be done as follows :—

If V is the potential difference at the dynamo, n the length of the line in miles, then the power in watts received at the far end is

$$C\,(V - C\,n\,r),$$

and the power put into the line in watts equals

$$C\,V + n\,\frac{t^2}{r},$$

the second term in this latter expression representing the power used in the form of interest on the capital that has been expended on the conductor. Hence the efficiency equals

$$\frac{C\,(V - C\,n\,r)}{C\,V + n\,\dfrac{t^2}{r}}.$$

Differentiating with respect to C and equating to nought we find that

$$C = \frac{t}{r} \cdot \frac{\sqrt{n^2\,t^2 + V^2} - n\,t}{V}$$

makes the efficiency a maximum.

Hence we see that $\frac{t}{r}$, as given by Sir William Thomson, must be multiplied by the factor

$$\frac{\sqrt{n^2\,t^2 + V^2} - n\,t}{V},$$

a factor depending on the length of the line, and on the potential difference at the dynamo, in order to obtain the proper value of C.

For V equal to 80,000 volts, and n equal to 300 miles this factor becomes

$$0{\cdot}8333,$$

hence we submit that with the 300 miles of copper conductor half an inch in diameter the proper current to employ with the particular number of hours of working, the cost of copper, the rate of interest on money, and the yearly value of a horse-power at Niagara taken by Sir W. Thomson is not 240 ampères, as stated by him in his inaugural address, but

$$240 \times 0{\cdot}8333, \text{ or } 200 \text{ ampères},$$

in order to obtain maximum efficiency.

AN ELECTRICALLY PROPELLED SUBMARINE BOAT.

ELECTRIC launches have been successfully worked in this country for nearly four years past, and we have had records from time to time concerning this interesting and important development of electric locomotion. There are several of these launches of various sizes in England, all of which appear to have given great satisfaction. Their utility has been so fully demonstrated, that we have had hopes of seeing electricity applied to the propulsion of submarine boats; this hope seems now to be realised, and we are pleased to reproduce a paragraph from a local newspaper which gives an account of such a vessel—the first in this country—devised by Mr. J. Waddington of Birkenhead. Electricity from storage batteries appears to be far more convenient and safe than steam for such a purpose, and we feel certain that Mr. Nordenfeldt will adopt this mode of propulsion in his successful submarine vessel; we have, however, great doubts about the statement in the paper referred to, viz., that with 50 cells Mr. Waddington's boat can be driven at a speed of nine miles an hour for ten hours, and that at a slow speed it can run for about 250 miles without recharging. We should be glad to hear that this can be done, although the figures given are greatly at variance with our experience concerning the possibilities of existing appliances.

The following is the cutting which forms the basis of the above comments :—

An electrical submarine vessel has recently been tried at Liverpool with complete success. The vessel, which is cylindrical in shape, is about 37 feet long overall, 6 feet diameter amidships, tapering to a point at each end. A conning tower is placed on the top of the vessel, in the sides of which are ports which enable the

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steersman to see in every direction, and which is covered by a strong watertight scuttle for access to the interior of the boat. The depth of the vessel below the surface of the water is regulated by two inclined planes, one on each side, worked by a lever amidships; and in addition there is a rudder aft, worked by a self-acting arrangement for keeping the vessel always in a horizontal position. The interior fittings are so arranged that the boat may be worked by one man, but the usual crew would be two men. At each end of the boat is a compartment for the storage of compressed air, which can be used when the boat is kept below water for a lengthened period. At the same time, owing to the absence of boiler, fire, &c., there is sufficient air space for two men to remain below water for six hours without drawing on the storage. The motive power, electricity, is stored in fifty large accumulator cells, which, when charged, are capable of driving the boat at the speed of about nine miles an hour for ten hours, either at or beneath the surface of the water, or at slow speed will drive her for about 250 miles without recharging. The motor drives the screw direct at about 800 revolutions per minute. This motor can also be coupled direct to a centrifugal pump, which, in a few minutes, empties the water ballast tanks which are used to submerge the vessel. The interior is lighted by incandescent lamps, in addition to which there is a powerful electric search lamp on the conning tower, which enables the steerman to see below water as well as above. This is the most powerful installation of electrical power ever fitted to any boat, and has been most successfully carried out by Messrs. Perry and Cox, of Liverpool. The storage cells being supplied by the Electrical Power Storage Company, London. One of the chief advantages claimed by the inventor is that a boat of this description can be carried on the davits of any man-of-war, and the cells charged from the dynamos whilst hanging on the davits. She is thus ready for use at once. A further trial of this interesting vessel was made in Liverpool in the presence of inspectors from the Admiralty on Wednesday the 31st ult., and proved most successful. The Admiralty inspectors expressed themselves highly satisfied with the results.

THE STRANGE HISTORY OF A DYNAMO,

As told by itself to

A. DYNAMICABLE.

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WHERE is the man, electrician, engineer, pure scientist or simple layman, who, if he has passed the meridian of life, has not in moments of reflection been struck with amazement by the contrast between the limited stock of information at command in the days of his youth and the extensive knowledge now prevalent regarding the practical applications of the still mysterious phenomena of electricity? In no age has science—and collaterally, it is pleasant to remark, the popular interest in scientific subjects—made such distinguishable advances as in that in which we live. What are now well-defined and settled laws were half-a-century back but the conjectural and timidly-advanced speculations of a few earnest philosophers, who ardently hoped, but scarcely dared express an assured belief, that they were in the path of true knowledge. Likewise, in the applications of abstract theories to material forms, what were a generation or so ago crude and apparently useless laboratory and lecture-room playthings have developed with astounding rapidity into the beautiful and wonder-working paraphernalia upon which the enlightened engineer of to-day relies for the accomplishment of his most ambitious designs.

Undoubtedly it is in the domain of electricity that Nature has latterly been most abundant in her revelations to mankind, and the devotee of that grand branch of physical science, if he be humble and true, feels the heart within him leap with exultant joy as he surveys the products of the genius of those inventive and intellectual giants, Arago, Ampère, Faraday, Wheatstone, Siemens, Thomson—surveys what these have done and reflects upon the glorious possibilities of the future, in the realisation of which he would fain bear a part.

"Hope springs eternal in the human breast;"

and it is this bright beacon-star which guides ever onward the earnest, but often weary searcher after truth—the hope of living not in vain, of ending this pilgrimage on earth with the solacing knowledge that something worth the doing has been accomplished and the world thereby left the richer. Certain names in every generation shine brilliantly forth and attract to themselves the admiration and the reverence of the multitude; but besides these there are hundreds upon hundreds of others, equally devoted, some perhaps equally able, lacking only opportunities for the display of their wealth of knowledge, who work and work on, unheard of except in a limited circle, never meeting with the recognition which is their due from the great world outside. Yet to the labours, incessant though unseen, of these noble men must be attributed that steady, irresistible forward march of civilisation, of culture, religion, science, everything, in fact, which is great and good, of which we are the privileged witnesses. It is because of the perfection of its minutest details that the huge machine works perfectly; it is the unremitting zeal, the ever-vigilant care of the thousand-and-one silent workers whose names are never known that give point and substantiality to the progress of the age. While honour and awe and undying fame are accorded to those who rise to sublime pre-eminence and are seen of all men, let us not forget to invoke blessings upon the heads of their less favoured contemporaries, followers—ay, brethren. One often wonders, do the masses ever dream of the infinite labour, the matchless skill, the indomitable determination which these ever-busy minds bestow upon their engrossing endeavours to coax from coy Nature her cherished secrets? It is the mission of the great ones of the earth to speak to the people of the wonders which would else remain hidden from the public gaze and incalculably less useful; but in the result are they not regarded as men who are inspired, upon whom the divine afflatus has descended with dazzling suddenness, imparting more than human power to discern, construct, and display? Are not the ignorant like men in the city street who pass by and heed not the stately edifice rising stone by stone behind the high and ugly hoarding, and are ready to attribute its appearance to a miracle when suddenly it stands forth in the fulness of its architectural glory, bereft of all that previously dwarfed or hid its beauties? When the patient toil of many heads and many hands through long, long years of alternate hope and despair at length reaches its climax in the perfected presentment of a magnificent work, as complicated as beautiful, and rich in possibilities of usefulness to mankind, do not the vulgar too often regard this thing of beauty merely as the latest "seven days' wonder," the inspired conception of a night and the work of a day?

But enlightenment is spreading fast; and who dares attempt to stay its progress? Let us rather each and every one put our hands to the plough, and push sturdily onward in the endeavour to lift our less privileged brethren from the slough of ignorance and indifference into which the force of circumstances has thrown them! Let us no longer be the selfish and exclusive beings we have been so long; let us take these works of skill and art and display them to the uninitiated—explain them wheel by wheel, plate by plate, and coil by coil, until we see the dawning of an appreciation of their beauty and their worth!

Ruminating in some such vein as this, I sauntered one sultry July day in 1885 from court to court of the Exhibition of Inventions which that year attracted me and millions more to South Kensington.

An engineer by profession, at heart a disciple of Faraday, Wheatstone and Siemens, and at the same time an ardent admirer of Swedenborg, that extraordinary being in whom were combined the rarest scientific genius and the less rare but, in this instance, equally marvellous traits of the visionary religionist—little wonder that the things I that day saw enslaved both my mind and my imagination. Hour after hour I spent in this department and that, examining minutely the objects most closely allied with my own pursuits, regarding more generally, but with not less admiration, the skilful productions of brains and hands which plot and fashion in fields widely different. I had entered the building amongst the earliest visitors,

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and from the moment my gaze lighted upon the first piece of mechanism within sight no thought of time or space intruded until I had made the complete round of the exhibition. By this time it was noon; but feeling no need of refreshment, I resolved to indulge myself with a more prolonged inspection of those objects which had particularly struck my attention.

I was alone; nor did I desire a companion. Was I not surrounded by the essence of the Great of past ages—nobler company than aught having the living human form could supply? The genius of a thousand generations was incorporated in the grand achievements which greeted my vision on every side, and the exalted minds of philosophers who had passed from existence centuries before seemed spiritually present to me as I regarded the rich fruits of their almost forgotten labours. I took little heed of the swaying multitudes, except occasionally to wonder if *they* divined of aught beneath the surface of appearances, or if they attributed to the thought of *one* man the existence of each marvel upon which they bestowed a moment's curious glance; and they, in return, left me undisturbed in the full enjoyment of my almost ecstatic reveries, which seemed momentarily to transport me from the realm of things material to a spirit world, where I revelled in the fancied companionship of the greatest masters of science and of philosophy whom the ages have produced.

In this state of mental exaltation my wanderings hither and thither brought me in the course of time to an annexe wherein was gathered a vast aggregation of engines and dynamo-machinery, serving both the purposes of display and use, for here was the source of that brilliant illumination which was a notable and an attractive feature of the exhibition. Now I was in my happiest element. Conscious, at length, of the need of rest, I sat down, and gave myself up entirely to the delight of untramelled fancy. I regarded with feelings of affection the various machines around me, familiar to my eyes as the forms of the members of my own family. They were not all alike, but bore to each other just such resemblance as one sees in the different children of the same parents: this bore the name of Siemens, that of Gramme, another of Edison; others there were of various nomenclature, but in all was observable the same underlying principle of action. The varying shapes and methods of arrangement were testimony to human ingenuity; but they conveyed too a pathetic story of the limitation of human knowledge. The observance of one particular natural law, or combination of laws, was imperative, in however many different guises presented. One machine exists by reason of the action of its heart and lungs and circulating vital fluid just as does every other, and one man is no more its originator than is the immediate progenitor of the last-arrived member of the human race. The child bears the father's name, and that father is regarded as the author of its being; but he is not the inventor, the originator of humanity. Though the specimen for which he is immediately responsible presents an appearance different to all surrounding specimens, the type upon which it is based existed thousands of years ago and was the work of a far mightier hand. Man in the course of ages, by reason of illumination from outside himself—from above—has improved man, sometimes in the body, sometimes in the spirit—physically, mentally and morally—but he never yet invented man. Nor did any one individual invent the dynamo machine: to one it was given to perceive the existence of a law; he proclaimed that law, and another discovered an application for it; still another improved the application, and subsequent workers added to the improvements of the last—but none invented a new law upon which an entirely new machine could be built to subserve the same end.

"True, true—true, true; very true!"

A soft murmuring voice, conveying these words to my ears, proceeded from somewhere near me; but I could see no speaker. I looked around; no one was near. Workmen were busily engaged in another part of the building—too distant for me to hear them speak; and it was not the voice of a workman.

I listened intently, and kept my eyes fixed on the spot whence had seemed to come the gently spoken words. I had not long to wait for a repetition of the strange sounds, for again came the murmuring tones:

"You surmise truly. Man was not made in a moment; nor was I."

"And who are you?" I ejaculated, in vague wonderment, eagerly scanning every visible part of a bright looking dynamo in front of me, which was running with even speed and easy motion. By degrees the notion entered my head that it was this machine which had addressed me. As I looked more closely, sparkling eyes and smiling mouth seemed to appear,—but they were not like human eyes and human mouth. The longer I gazed, the more plainly I discerned that the swiftly revolving form before me was an animated being. Half unconsciously I repeated, "Who are you?"

"What I am you may see," came the smiling rejoinder; "but all that I have been you do not know."

"Are you not a dynamo?"

"I am now called by that name; but I have borne other names in times past, and have held different forms."

"Other names, and different forms! What mean you? I desire, I pray for enlightenment."

"And it is my duty, as well as my privilege, to give to you that enlightenment, and, through you, to the world."

"Through me! enlighten the world! Oh, strange being, what would you have me do?"

"Write! and write as I tell you the story of my existence. Learn how from little things comes that which is great and mighty. Write, and tell mankind how, while it took its ease and dreamed that it knew all things, a few men laboured earnestly, and were rewarded for their labours, having confided to them great truths, and bestowed upon them the knowledge of great laws—some of the laws which regulate the universe—how these continued to labour in the light of the few truths and little knowledge vouchsafed to them alone, and how these, and those whom they instructed, wrought their ideas into forms which the world first laughed at, then regarded with curiosity, increasing to wonder and awe, and which they finally worshipped. Oh, the foolish, mad world! In its ignorance it deemed itself wise unto all knowledge; when something beyond its comprehension appeared, it was supernatural, unearthly, to be feared—and worshipped! But I speak of a past age. We are in other times now. And still a new era is dawning—knowledge is to become universal, and you and I are instruments by which knowledge is to be extended."

The tone had changed from the soft, murmuring sound which first greeted my ears into one which was sonorous and almost commanding. The form seemed to change, too, to magnify and approach nearer and still to change, until I was conscious of a tremendous presence at which I scarcely dared look. Eloquence and command were in the tones and in the attitude.

"Write!" once more came the voice; "write what I bid you set down, and when I have told you all, take and publish it to the world."

Pencil and tablets were ready to my hands, and mechanically I prepared to obey. The voice proceeded, and I wrote as it spoke:

"I am not one machine only; I am not one form; but the incarnation of many. I am the first which was made, and I am the last which left the makers' hands. But I will tell you my history from the beginning."

THE DYNAMO'S STORY.

It is not by any means an easy task to relate one's own history, but as my present position in the world is now so well defined, I ask you to bear with me in my brief endeavours to make the story of my past life intelligible, hoping that some rays of light may be thrown upon that which has been, and is still

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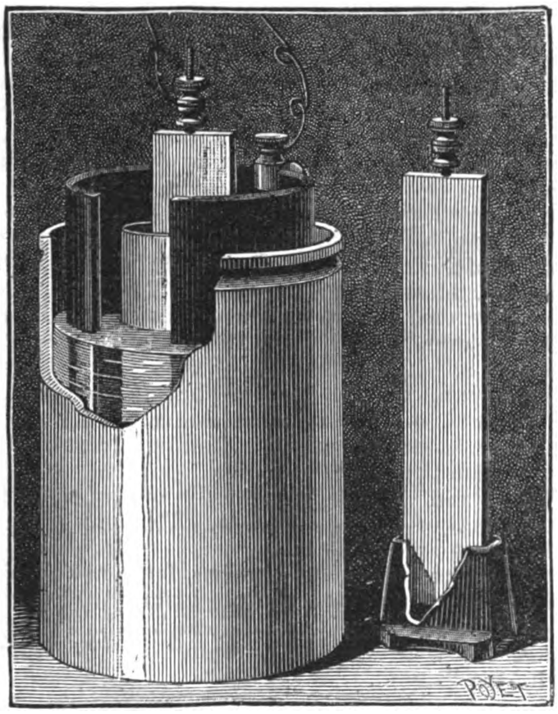
to the uninitiated, wrapped in a veil of obscurity. The technical name I bear has now become almost a household word, but about my parentage there is still some uncertainty. I must, therefore, be excused if I refrain from going too deeply into family matters, for my ancestry does not affect the present generation; suffice it to remark that I, like Topsy, "growed." Still, although my objections on this score are well founded, I may nevertheless, through you, give mankind a slight clue to my origin. My beginning, like that of the genus "homo," which, we are credibly informed, was evolved from that inanimate looking object, the jelly fish, was sufficiently primitive and crude to keep me in an embryo state for many long years, although I was ready at any moment to have assumed my present form had but the time been opportune for my entry into the world.

Till within the last decade I had somehow laboured under the impression, probably through forgetfulness of my early and incompletely imbibed knowledge, that the first discovery from which I became as it were evolved was made by one Romagnosi, an Italian. It is now, however, perfectly clear to me that the honour of the discovery of the much sought for connection between electricity and magnetism is due to the illustrious Danish Philosopher Œrsted.

This justly celebrated man, found that a closed galvanic circuit caused a magnetised needle brought within its influence to be deflected. I cannot but assume that those to whom you on my behalf will address yourself have seen and used a magnet or a magnetised needle, for these must, in the present days of enlightenment, be perfectly familar to even the youthful reader of both sexes. I will, however, at the risk of being thought dry and tedious, even at the beginning of my narrative, place before you a representation of a closed galvanic circuit. I must again assume, so as not to be thought a too garrulous specimen of my class, that you are aware that there are various sources, discovered before I was even thought of, of electrical energy.

That which will best suit the purpose I have in view is a galvanic battery, which I need scarcely remind you is usually composed of plates of different metals or plates of metal and carbon immersed in acids or



RADIGUET'S CELL.

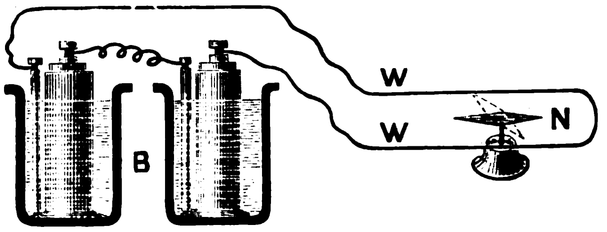
alkalis of various kinds. You think it well that I should more clearly describe one of these sources of electrical energy! Perhaps you are right, and a recent battery which has just been brought to me and which is used for producing the latest and best form of illumination—the electric light—will well answer our purpose. It is the production of one Radiguet, and it has recently undergone improvements which render it a very practical apparatus. It consists, as you see, of an outer jar of enamelled stoneware, containing an acid concentrated solution of bichromate of potash, a cylinder of carbon the head of which is paraffined, and in the middle of which is placed a porous jar the top and the bottom of which are also paraffined. This porous jar contains water acidulated with sulphuric acid in the proportion of 1 to 10. The zinc, which it also contains, is kept constantly immersed; the lower part is constantly in contact with mercury contained in a basin the outer surfaces of which are inclined. This basin is of great importance, as it enables the zinc to remain immersed without being consumed.

If the mercury is simply poured into the bottom of the porous jars, besides the fact that a great quantity is required owing to the convex form of the bottom, we observe that after some hours of working, the mercury becomes rapidly coated with sulphate of zinc, and that this scum eventually adheres to the zinc and to the mercury and completely covers the latter. At the place where the zinc and mercury are in contact, a kind of film is formed which completely prevents all contact between the zinc and the mercury and even hinders the mercury from penetrating into the pores of the zinc.

M. Radiguet's basin obviates this difficulty; the sulphate of zinc that is formed slipping over the outer surfaces, the mercury remains unaffected and in constant contact with the zinc. The acidulated water of the porous jars is changed after seven or eight hours of lighting. The same bichromate can be used for four charges of the porous jar, or for about 30 hours.

If we collect a sufficient number of cells together containing these elements and connect their poles or terminal plates by a length of wire, a chemical action is set up between the elements of which the battery is composed and that mysterious force with which we are ere long to become so familiarly acquainted is energetically produced.

In the sketch which, by the aid of your pencil I present you with, a battery or source of electrical energy, B, is joined up in a continuous circuit by a length of wire, W,



A CLOSED GALVANIC CIRCUIT.

and between the loop formed by this wire the pivoted magnetised needle, N, is placed. This will, by the action of the galvanic current, be immediately deflected or turned aside as shown by the dotted lines, and this is the important discovery which had the first bearing upon my existence.

(*To be continued.*)

SELF-INDUCTION AND INCREASE OF RESISTANCE FOR INTERMITTENT CURRENTS.

By Profs. W. E. AYRTON, F.R.S., and JOHN PERRY, F.R.S.

IN view of the able article that has recently been contributed to *La Lumière Electrique** by Prof. Weber, of Zurich, in which the conclusion is drawn that all Prof. Hughes's new results are due to a wrong interpretation of his own experiments, it may interest your readers to see the remarks made by one of us during the recent discussion on Prof. Hughes's paper, since, although it is

* See also present issue of ELECTRICAL REVIEW.

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doubtless true, as proved by Lord Rayleigh, that some portion of the results are due to the fact that effects of self-induction and of resistance are not wholly separated in Prof. Hughes's apparatus, we think it may not follow, as Prof. Weber now concludes, that there is no increase of resistance for an intermittent current. In the discussion one of us stated:—

Prof. Silvanus Thompson has referred to certain work of my colleague and myself on self-induction, and therefore I take the liberty of rising to prevent a possible misconception being produced in the minds of those who have heard Prof. Thompson speak. It is quite true, as he said, that we showed some time ago that when an intermittent current passed through a coil the effect of self-induction might in certain cases be expressed simply as an increased resistance of the coil depending on the period of the intermittency; but I think that that is not the increased resistance that Professor Hughes has brought to our notice, and I am inclined to think that perhaps the most important point in Prof. Hughes's paper has been overlooked, I think I may say, by almost every speaker except Prof. Forbes. The increased resistance which we showed an intermittent current to give to a coil was an increased resistance which, as Prof. Thompson has shown, can be arrived at by the ordinary mathematical calculations. Now the question arises, Is the *whole* of the increased resistance that Prof. Hughes has shown us to exist in a wire through which an intermittent current is flowing capable of being anticipated from the ordinary mathematical calculations? It could, of course, be obtained if one had a complete knowledge of nature; but can it be obtained from the ordinary mathematical calculations as they are given? I think the answer is, No.

We are so imbued with ordinary mathematics that somehow or other we try to explain all the results that Prof. Hughes has obtained by the ordinary laws. I am not quite in agreement with Mr. Preece when he points out that mathematics, or theory, have always been behind experiments. In many cases that criticism is unfortunately quite true; but I think Sir William Thomson's theory regarding the retardation in submarine cables was elaborated, and the laws of the proper way in which cables should be made arrived at, before the conclusions were verified experimentally. In fact, the deductions drawn by Sir William Thomson regarding the propagation of electric waves in long submarine cables by employing the system of mathematical analysis that Fourier had used in investigating the flow of heat along a bar constituted one of the most brilliant examples of theory leading practice, and made telegraphing through long submarine cables commercially possible. Without this mathematical work of Thomson's the results could only have been arrived at experimentally with the expenditure of a vast amount of money. Did time allow, it would be possible to mention many other cases where theory has been in advance of experiment.

Returning now to Professor Hughes's results, this question of increased resistance as distinct from self-induction is very, very important indeed. Mathematicians have usually assumed that in a simple circuit the growth of the current could be expressed completely if the law of variation of electromotive force were known, as well as the resistance and coefficient of self-induction. My attention was, in any marked degree, first directed to the insufficiency of the ordinary mathematical analysis in this particular by a very curious experiment that was described to me some time ago by Captain Cardew. He told me that he had found out experimentally that if the mean square of an alternating current was measured by a Siemens dynamometer, the same result was not obtained as the mean square measured by the heat of an incandescent lamp; *i.e.*, if you altered the period of alternation of your dynamo machine so as to keep the luminosity of the lamp perfectly constant, then the mean square of the current as measured by the Siemens dynamometer appeared to be different. On discussing that with my colleague, Professor Perry, he said that it probably meant want of uniformity of distribution of the current density in the wire of the dynamometer—a fact that was also referred to by Dr. Hopkinson, you may remember, at the last meeting, but I do not know whether he knew of the experiment of Captain Cardew to which I have referred. The important point to which Professor Hughes has drawn attention is, I think, that it has led us to see the important effect produced by this want of uniformity of the current density, even in a straight conductor.

Professor Thompson has just said that he could not agree with the view stated by Professor Forbes that a current on starting went one way in the middle of the wire, and the other way in the outside; and I do not myself quite agree with that way of expressing this want of uniformity in current density. No doubt, if you had what Professor Forbes assumed—a current passing down the outside, and going up on the inside—you would have a waste of power, and consequently the effect of an increased resistance. But it is not necessary to assume a flow in opposite directions to explain the phenomenon; for if you have any want of uniformity of current density in a conductor, my colleague and I have shown, in the following very simple way, that there must be an increase of resistance. For what do we mean by resistance in such a case? We mean increased heat generated per second per unit current; and it is quite easy to show that if you have a given current passing through a given wire, and if by any means you are able to destroy the uniformity of current density, then, without any current passing in the opposite direction in any part, there must be an increase in the expenditure of power—that is, an extra production of heat per second per unit current, or an increased resistance.

Let C be the total current flowing through a wire, and let c be the current per unit area at any point of the wire, so that if da be the area of a small portion of the cross section,

$$\iint c \cdot da = \text{C} \qquad (1)$$

Let A be the area of the cross section, then $\frac{\text{C}}{\text{A}}$ is the mean current per unit area, and

$$\iint \frac{\text{C}}{\text{A}} \cdot da = \text{C} \qquad (2)$$

If we consider any elementary filament of unit length of the wire, its resistance

$$\propto \frac{1}{da};$$

hence, since the current along the filament is $c \cdot da$, the rate of generation of heat in this filament is

$$\propto (c \cdot da)^2 \times \frac{1}{da},$$

or

$$c^2 \cdot da$$

Hence the rate of development of heat in unit length of the whole wire is

$$= \text{K} \iint c^2 \cdot da,$$

where K is a constant.

On the other hand, if the current density were uniform, and equal to the mean current density, the rate of development of heat would be

$$= \text{K} \iint \frac{\text{C}^2}{\text{A}^2} \cdot da.$$

But the current density not being uniform, let

$$c = \frac{\text{C}}{\text{A}} + x \qquad (3)$$

where x may have any positive or negative value; then

$$\iint c^2 \cdot da = \iint \frac{\text{C}^2}{\text{A}^2} da + 2\frac{\text{C}}{\text{A}} \iint x \cdot da + \iint x^2 \cdot da.$$

But

$$\iint x \cdot da = 0,$$

since from (1), (2), and (3)

$$\iint c \cdot da = \iint \frac{\text{C}}{\text{A}} da,$$

and $\iint x^2 \cdot da$ is essentially positive. Hence

$$\iint c^2 \cdot da > \iint \frac{\text{C}^2}{\text{A}^2} da;$$

or the rate of production of heat when the current-density is not uniform is greater than when the current-density is uniform for the same total current. That is to say, apart from what is usually understood by self-induction, there will be a seeming increase of resistance if the current-density is from any course not a uniform one. Now when a current starts or stops in a wire there must be *mutual induction* between the various streamlets of current in the wire; hence we may expect that on starting a current the current-density will be greatest near the surface of the wire and least near the centre, whereas on stopping the current it will be at the centre of the wire that the current-density will be a maximum. And since, as I have shown, any departure from a uniform current-density leads to an increase of resistance, it follows, as Professor Hughes has experimentally shown, that both on starting and on stopping a current there is an increase of resistance.

This, I think, is perhaps the most important of all the things that Professor Hughes has drawn our attention to. Some speakers at the last meeting, and others this evening, have endeavoured to explain his results somehow or other by the ordinary mathematical calculations, but I think we shall have to modify our calculations; in fact, Professor Hughes has led us to see that even in the single straight conductor it is necessary, not merely to take into account the self-induction of the conductor, but also the well-known phenomenon of *mutual induction*, which has hitherto been usually confined to the induction of one current on another. In future, it seems possible that we shall have to introduce into our mathematical expressions, in order to express the true state of nature, a term dependent on the mutual induction of the various streamlets of the current, one on the other, which has the result of producing a want of uniformity of current-density, or, more simply, has the effect of producing a real increase of the resistance, altogether distinct from self-induction, of a wire traversed by an intermmittent current.

The Legion of Honour.—Dr. Cornelius Herz, we learn, has been promoted to the rank of Grand Officier de la Legion d'Honneur.

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ELECTRIC LIGHTING BILLS.

House of Lords, April 1st.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (No. 3) BILL.

LORD HOUGHTON, in moving the second reading of this Bill, said that when the two previous Bills on this subject were before the House he had stated that it was the intention of the Government to bring in a Bill of their own. The Bill only consisted of one clause. By the present law the ordinary course was for a company to apply to the Board of Trade for a provisional order, which was given for a term of 21 years, at the end of which, or at the end of any subsequent period of seven years, the local authority was empowered to buy the undertaking on certain terms. The Bill enlarged the time to 30 years, and, provided the consent of the local authority was obtained, to 42 years. Then, at the end of every ten years, the purchasing powers of the local authority might be exercised. He should, however, be willing to add a clause leaving it to the discretion of the Board of Trade to increase the term to 40 years. It was the firm belief of the Government that this Bill would satisfy those who desired to promote electric light undertakings.

The Earl of CAMPERDOWN had no objection to the second reading, as no doubt some modification of the existing law was required. But the Board of Trade were thoroughly justified in taking every precaution that the public should not be exposed to losses in respect of electric lighting similar to those which they had incurred with respect to gas and water. The compensation to be given to companies at the end of the terms should be of a fixed amount.

Lord RAYLEIGH had no objection to the second reading, as the Bill was some improvement on the existing law. But no mere extension of time would meet the requirements of the case if the very stringent terms of purchase now imposed were not modified, and if no compensation were to be allowed in respect of goodwill or profit. During the last years of the term the enterprise would suffer greatly from the difficulty of carrying out improvements and maintaining the plant in order.

The Bill was read a second time.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (Nos. 1, 2 AND 3) BILLS.

Viscount BURY, in rising to move that these three Bills be referred to a Select Committee, said that the Act of 1882 had been found to be insufficient. But no mere extension of time would be sufficient. The best course would clearly be to refer the three Bills to a Select Committee. He belonged to a society which comprised distinguished men of science like Sir W. Thomson and men who were acquainted with the practical application of science like Mr. Preece, of the Post Office, and which might, in distinction from the purely scientific and commercial aspects of the question, be fairly said to represent educated public opinion on the subject. It was most important that the evidence of such persons should be taken, and clearly the best way of dealing with the question was to refer the three Bills to a Select Committee. He thought that the Bill which he had the honour to introduce dealt with the subject in a much simpler manner. It provided that electricity should be supplied by meter, and that the company should not interfere with the manner in which the user of electricity chose to use the electric energy placed at his disposal. There was hardly any limit, he might observe, to the ways in which electricity might be used, and more than one meter had been found which was accepted by electricians as efficient. These were matters, however, for expert evidence, and they could be discussed far better before a committee than by talking about a Bill over their lordships' table. This was one reason why he thought all these Bills should be referred to a Select Committee. If his noble friend's Bill as it stood became law it would be impossible to get capitalists to embark a sufficient amount of money in the undertaking with any fair prospect of success. His noble friend opposite stated that there were some purveyors of electricity who were willing to come under the terms of his Bill. It might be so, but he would venture to express his belief that the terms would not be sufficiently attractive. His own Bill differed in one respect from that of his noble friend behind him, who proposed that electricity should be put upon the same footing as gas, and that there should be no fixed date at which the concerns should be handed over to the local authority, but that, like gas companies, they should be perpetual, and that only their dividends should be restricted. His scheme was that at the end of 40 years the local authorities should, if they so desired, have a power of coming in and buying the concern at a fair price as a going concern. He concluded by moving that the three Bills be referred to a Select Committee.

Lord GRIMTHORPE said that the question seemed to be whether municipal bodies were to be authorised at the end of some period which was uncertain to buy the undertakings of electric light companies for something less than they were worth. Was the corporation of any town to be allowed to buy a going concern for something less than it was worth from those who had had the risk of starting it and keeping it going? In support of that proposition he had heard nothing except that the corporations would like it. It was entirely uncertain whether electric lighting companies would be financially successful or not, but although their success was so uncertain, the House was nevertheless asked to give corporations the opportunity of playing the game of "heads I win, tails you lose" with them. If the companies paid and became prosperous the corporations would buy them; if not they would leave them alone. He would admit that the companies ought not to receive the extra price allowed by surveyors for compulsory purchase, usually 10 to 20 per cent. But he was convinced that to give municipal bodies a right which not even the State had ever before enjoyed, would, instead of encouraging the development of the electric light, only bring into existence financially weak and incompetent companies.

Lord HOUGHTON observed that the question whether the Bills should be referred to a Select Committee rested entirely with their Lordships' House. If he were right in supposing that the Government Bill would be satisfactory to the promoters of electric light undertakings, it did not seem to him under those circumstances that there was any reason for sending it to a Select Committee. The whole of this subject was threshed out thoroughly before a Select Committee of the other House in 1882, and a most voluminous report was made. All the technical questions to which the noble viscount had referred were then thoroughly gone into, and if another Committee were appointed the same evidence would have to be taken. He did not think that the result would be to place the Committee in possession of any new scientific or commercial fact upon the subject. Moreover, to send the Bills before a Select Committee would be practically to prevent any legislation taking place before the end of next session.

Lord BRAMWELL expressed the opinion that these Bills ought to be referred to a Select Committee. He did not wish to find the least fault with those who were responsible for the original Act, by which the electric light companies were given a lease of life for 21 years. No doubt the authors of that Act were actuated by the best possible motives, and were solely desirous of guarding the public against the people who embarked their capital in these undertakings. In attempting to make a good bargain for the public in 1882 the Government offered such terms as positively no one would accept. He believed that there had been one application only—he was not quite certain that there had been even one—for a Provisional Order under the Act of 1882. That this was the case was not surprising. If at the end of 21 years the undertakers were bound to sell their property, not perhaps at the price of old iron, but for a comparatively small fraction of its cost, capitalists would not embark their money in the undertaking. It might very well be that after struggling against difficulties for many years, just as a company had overcome them and were but just beginning to be able to pay a reasonable dividend upon their shares their terms of concession would expire, and the local authority would step in, and being able to borrow money at 4 per cent., would buy them out. The proposal contained in this Bill was that the term of concession should be 30 years, or, with the consent of the local authority, 40 years.

Lord HOUGHTON said that in the event of the local authority objecting to an extension of the term the Board of Trade would be empowered to extend it to 40 years or longer with the approval of Parliament.

Lord BRAMWELL said that in 1882 the Government had only offered half the advantages to a company that they did now, but he was positively assured that even the terms now offered were so bad that even under the new Bill, as under the old Act, there would be no electric lighting. He did not think that their lordships would without further information arrive at the conclusion that 40 years was a sufficiently long term, and, therefore, without the slightest desire to oppose this Bill or to throw difficulties in the way of the Government, he begged to move that the Bill be referred to a Select Committee.

Lord RAYLEIGH pointed out that the history of the Act of 1882 showed that the original proposal of the Board of Trade was that the term should be seven years only. That term was extended to 14 years in the House of Commons and to 21 years by that House. In the circumstances, it was impossible to feel much confidence that the Board of Trade had hit the exact length of term necessary for these undertakings in the present measure. The stringency of the provisions of this Bill would probably prevent the public from obtaining the benefit of electric lighting at all.

The Earl of CAMPERDOWN thought that even a Select Committee would find it difficult to form a correct estimate of the length of the term necessary from the evidence of professional witnesses who were likely to appear upon both sides, and to give evidence opposite ways with equal positiveness.

Earl GRANVILLE remarked that the arguments which had been put forward in favour of sending this measure before a Select Committee were of a very different character. The Board of Trade were exceedingly anxious that this matter should be settled, as delay with regard to it was very injurious to the public interest. He entirely agreed that it would be an almost hopeless task for a Select Committee to attempt to settle the number of years term that would induce capitalists to invest money in these undertakings. He felt convinced that if the Bill came out of the Select Committee, and was approved by their lordships' House on the principle which had been very generally advocated that night, there was not the slightest chance of its passing through the other House of Parliament, and that the question would be indefinitely delayed. He quite admitted that it was a matter for the House itself to decide, and, as the opinion of the House seemed to be in favour of referring the Bill to a Select Committee, he could only join in the hope expressed by the noble lord who

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spoke last that a conclusion might be arrived at by the Committee as soon as possible.

Viscount CRANBROOK expressed his gratification that the noble earl opposite had assented to the reference of the Bill to a Select Committee. Their lordships could have but one feeling—namely, that the question should be dealt with as speedily and at the same time as soundly as possible. What they desired was that some means should be found by which the public of this country would more largely enjoy the benefits of that invention. While full protection was secured to the public interest, they did not wish capitalists to be deterred, as they were at present, by the conditions of the existing law.

The Earl of REDESDALE suggested that the Select Committee should be a small one.

The Bill was then ordered to be referred to a Select Committee.

LEGAL.

Gilman v. the Gülcher Electric Light Company, Limited.—This was an action before Mr. Justice Grantham on Saturday last, brought to recover a sum of about £220 in respect of a balance alleged to be due to the plaintiff for services rendered to the company as a director. The defendants made a counter claim for the sum of £280, of which £100 was for calls on 100 shares standing in the register in the plaintiff's own name, and £180 on 120 shares, of which his wife was the registered holder. The plaintiff admitted his liability to pay the £100 on his own shares, but disputed the £180. It appeared that five was the appointed number of members of which the directorate was to be composed, and under the ninth of the articles of association, their remuneration was to amount to £1,500 a-year, to be divided according to the number of attendances of each director, or as the board might determine. Mr. Gilman attended the board meetings up to the end of 1883, when in consequence of the hostility between himself and the other directors he was obliged to cease attending, it being admitted that if he had persisted in doing so the only effect would have been that of preventing a meeting being held; and eventually, therefore, in 1885 he resigned his position. The defendants admitted that the plaintiff was entitled to £75, which amount, they said, was in proportion to the number of his attendances, and in accordance with article nine, but they denied that any were due to him for the period between the dates at which he actually ceased to attend and resigned, although they admitted that it was a matter of impossibility for Mr. Gilman to have attended, inasmuch as the other directors refused to sit with him, and this view his Lordship adopted. The case then resolved itself to the point as to whether or not the plaintiff was liable to pay the calls on his wife's shares, for which it was admitted that he had paid in the first instance, as also for calls made upon them subsequently. Mr. Justice Grantham said that although he did not like the decision in the Parsee case, which had been cited, yet he considered himself bound by it. He therefore gave judgment for the plaintiff for £75, and for the defendants for £100 on the counter claim, leaving a balance of £30 in their favour. Costs for defendants, and a stay of execution granted that the plaintiff might go to the Court of Appeal.

Varley's Electric Plant Debentures.—On Thursday, Vice-Chancellor Bacon was asked to appoint a receiver in an action, described in the *Financial News* as Barber *v.* Varley's Electric Plant Company, and as a debenture holder's action. The debentures became due on Wednesday, but on being presented for payment it was found there was no money, the effects of the company having been seized that day and sold to pay the salaries of the secretary and managing director. Vice-Chancellor Bacon granted a receiver. Is the Varley Electric Plant Company another name for the Varley Electric Patents Proprietory?

NOTES.

Electric Lighting in Factories.—Some time ago Messrs. Laird & Co., manufacturers, Forfar, entered into an arrangement for having the incandescent system of electric lighting thoroughly tested in their works. The trial from all points of view having proved satisfactory, an order was placed with Messrs. Henry Bennett & Co., of Glasgow, to fit up a complete installation in the calendering and finishing departments, and the work has just been successfully completed on the most approved design and construction. The dynamo used is one of Kapp's patent compound wound self-regulating machines. Between 80 and 90 lamps of 20 candle-power each are used, and are divided into three circuits. The switch board controlling these is placed above the dynamo, with a switch and safety fuse for each circuit. Each lamp is also provided with an independent safety fuse. The power for the dynamo is taken from the "Corliss" engine used for driving the calendering department. The lighting has now been in operation for several weeks, and has proved very successful in every respect.

Electric Lighting in Mines.—For some time past operations have been going on in the underground workings at Newbattle Colliery, with a view to obtaining fresh grips of the various seams of coal for which this colliery is famed. These operations, which are nearly completed, give every indication of proving successful beyond anticipation. Electric lighting and signalling apparatus have also been introduced in all the principal places in the mine.

Electric Lighting in New Orleans.—New Orleans has shown commendable enterprise in substituting the electric light for gas in illuminating its streets. The city covers a large area, and, with the exception of one section, where the contract with the gas company has still several years to run, is wholly lighted by electricity. There are two arc lighting companies in New Orleans—the Brush and the Louisiana. The latter has the contract for the street lighting, which runs for three years. It supplies 700 arc lights along the various thoroughfares. The Brush company lights the 14 different markets with 30 arc lights, and the parks with 18 arc lights. It also lights the river front for five miles, in which service 100 arc lights are employed, 250 feet apart. The latter contract is not made with the city, but with the lessees, a private company. The Brush company have just received the contract for five years, which would seem to indicate that the service has been satisfactory. The Louisiana Company has been devoting its attention almost exclusively to its big city contract, yet supplies about 200 private lights. Finding the old station at 119 and 121 Magazine Street entirely too small, it has just erected a fine, new station on the new levee. It will have a capacity for 1,500 arc lights. The company uses the Fort Wayne Jenney system, and has 50 dynamos in operation. Its repairs are done in its own shop, and its employés number about 100. The new station is expected to be ready in about two months. The Brush company is now furnishing about 600 private arc lights at prices ranging from about 40 to 60 cents a night. It also lights the Exposition with 170 lights in addition to 50 supplied to exhibitors there. This company is also arranging to go into the development of the incandescent lighting business. It is likewise about to enlarge its plant so as to supply electric power for running elevators, fans, sewing machines, &c. The company pays a regular quarterly dividend of 1½ per cent.

The Electric Lighting Act.—Messrs. R. E. Crompton & Co. have circularised "the trade" in the interests of Lord Rayleigh's Bill for the amendment of the Electric Lighting Act, asking for replies to the following questions:—(1) Has your business connected with electric lighting and electric transmission of power increased during the 18 months ending April 1st, 1886? (2) If so, what proportion of your orders has been for foreign countries and the Colonies, and what proportion for home consumption? (3) What number of hands do you consider find employment at your works, or in the pay of your agents in the United Kingdom, in the work of electric lighting and transmission of power? (4) Do you consider that the relaxation of the present legislative restrictions on house to house electric lighting would result in an increase of general business? (5) Do you think it advisable that the trade should act as a united whole to protect its interests in the Committee Rooms of the Houses of Lords and Commons by employing counsel, &c.? (6) If so, will you name the maximum amount you are prepared to give towards a guarantee fund to meet the necessary expenses?

Messrs. Crompton are actuated, no doubt, by the best

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motives in taking upon themselves the initiative in this matter, but we do not anticipate that they will receive many replies to the queries they have formulated.

Domestic Electric Lighting.—The final contract for lighting by electricity the well-known residence of the Right Hon. W. H. Smith at Henley-on-Thames has now been definitely signed and settled and the order placed in the hands of Messrs. R. E. Crompton & Co., thus adding another instance of the steady progress of electric lighting in private mansions and making an addition to the large number of such contracts which Messsrs. Crompton have successfully undertaken. The specification of the above work, which is of an exceptionally binding nature, has been drawn up by Mr. Musgrave Heaphy, and this gentleman together with Mr. Massey will act on behalf of Mr. Smith. The details of the contract may be generally stated as follows:—The plant will consist of one 12 H.P. nominal compound engine fitted with automatic gear, two fly wheels being used, each driving by belting one shunt-wound Crompton machine of the size known as pattern No. VIII. The boiler, which together with the engine is being supplied by Messrs. Davey-Paxman, is also 12 H.P. nominal, of the locomotive type, with special copper fire box. The engine and boiler will be fixed on independent foundations. The rest of the plant consists of a feed water heater, an inspirator, and an electric governor together with 60 secondary batteries guaranteed to maintain 60 lamps at their nominal brightness for 10 hours, this point being specially insisted upon in Mr. Smith's behalf in order to avoid Sunday working. The mains, which are heavy enough to carry current for 300 lamps (110 volts), are laid underground from the engine room to the house, and are of extra heavy insulation. The total number of lamps at present required is 200, but everything is arranged so that if desired an addition can be made to the lamps hereafter. The fittings are, generally speaking, of a simple character wherever suitable, flexible pendants being used; in other cases brackets or table standards are employed; all switches and cut-outs have to be mounted on non-combustible bases, and we need hardly add, all wires have to be run in strict accordance with the rules of the Phœnix Fire Office. The contractors have to guarantee the efficient working of the installation in every respect for a period of 12 months, including the secondary batteries. The contract is to be completed by July 1st, after which date we shall hope to be able to supply some further details as to the actual working and the actual arrangement of the plant.

The Society of Arts and the Electric Lighting Bill.—A petition was presented to the House of Lords on Thursday, 25th March, on behalf of the Society of Arts, by the Duke of Abercorn, C.B., Vice-President of the Society, in which the petitioners state that they are satisfied it would be to the public advantage that the use of the electric light should be extended, since the light is free from any deleterious influences upon health or upon property, and is, for many purposes, and in comparison with certain illuminants, economical, while its employment would, by competition, tend to cheapen artificial lighting generally; that if it is desirable to extend the use of the electric light, it is obviously necessary that it should be supplied in the same way as gas; that at present those willing to provide the electric light, in the same manner as gas is now provided, are hindered by the existing state of the law on the subject, and that in consequence the development of electric lighting in this country has not been equal to its development in other countries where no such artificial hindrances exist; and that the Bill (Lord Rayleigh's) now before the House provides for the application of similar clauses to any companies which may hereafter be formed to supply the electric light to the public, and thereby secures an efficient protection against the growth of a monopoly likely to be injurious to the public interests. They therefore pray that the House will take these premises into favourable consideration, and will pass the said Bill for the amendment of the Electric Lighting Act.

Electric Lighting at the Indian and Colonial Exhibition.—The electric lighting at the exhibition is under the control of a committee composed of Sir Frederick Abel, chairman; Sir Francis Bolton, who directs the garden illuminations; and Mr. W. H. Preece, who specially looks after the lighting of the buildings. The whole of the motive power required for the internal lighting of the exhibition buildings will be supplied under contract by Messrs. Davey, Paxman & Co., of Colchester; the power absorbed amounts to 1,200 indicated horse-power. The principal galleries and courts will be lighted by arc lamps, of which 160 are supplied by the Anglo-American Brush Electric Light Corporation, Limited; 140 by Messrs. R. E. Crompton and Co.; and 100 by the Pilsen-Jöel Electric Light Company, Limited; making 400 lamps in all, each lamp giving a light equal to at least 1,000 standard candles. The Indian Palace, the dining rooms, and the different offices in the "Old London Street" (or "The Old London World's Exchange," as it is to be called this year), as well as the Colonial and Indian tea houses, will be lighted by means of incandescent electric lamps, supplied with current by the Edison-Hopkinson dynamo machines. These machines are lent by the Edison-Swan United Electric Light Company, Limited. The Club dining rooms, over the West Arcade; the Chinese Pavilion: the Royal Box, underneath the clock tower; the secretarial offices, and the Subway to the South Kensington Station, will be lighted by incandescent lamps, which are fed by secondary batteries, lent by the Electrical Power Storage Company, Limited. These secondary batteries will be charged by Edison-Hopkinson dynamo machines. The electric illumination of the gardens will be effected by means of about 10,000 small glow lamps (mostly of 10 candle-power each); and, in addition, a number of arc lamps suspended from tall masts will be used to give a strong moon-like effect when the illuminated fountains are not playing. This installation, as well as the whole of the work connected with the fountains, which have been enlarged and altered, has been carried out by Messrs. Galloway and Sons, of Knott Mill Ironworks, Manchester.

Electric Lighting Contracts. — Messrs. B. Verity and Sons have obtained the following installations during the month of March:—The Junior Carlton Club, Pall Mall, with the whole of the machinery in duplicate, and a set of accumulators, capacity, 1,000 ampère hours; the Alhambra Theatre, 100 lights; and Starborough Castle, 120 lights, with a set of accumulators, capacity 500 ampère hours. The Junior Carlton Club makes the third of the London clubs entrusted to Messrs. Verity, the other two being the Constitutional and the Naval and Military.

Pamphlet on Electric Lighting.—Prefixed to their price list Messrs. Swete and Main, of the Baskerville Works, Battersea, have an exposition in popular language of the requirements and methods of electric lighting.

The Telephone in Portsmouth Dockyard.—Admiral Sir George Willes, Commander-in-Chief at Portsmouth, has abolished the semaphore on the top of Government House, and telephonic communication has been established with the dockyard semaphore in its stead.

The Northern District Telephone Company.—With the advent of fine weather, and the absence of snow, work on the trunk lines in the district of this company is being pushed forward briskly. Communication between Middlesborough and Stockton was established this week, and the list of subscribers in those towns and Hartlepool is beginning to assume very important dimensions, while, as the trunk line between Hartlepool and Stockton

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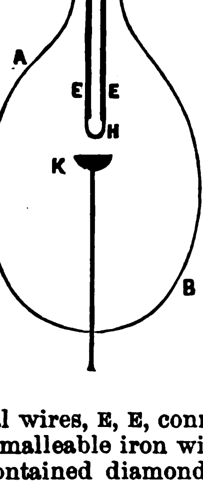
will be completed very shortly, and that between Sunderland and Hartlepool is progressing rapidly, all these important towns will very soon be in connection with one another. Active steps are being taken to connect the city of Durham, and a line will be run between that place and Newcastle, and an exchange opened there. Though Durham, like most cathedral cities, does not promise a large field for telephone enterprise, there being very little business done there, and people having plenty of time to walk about, and see one another, whenever such a rare thing as business requires such an unwonted exertion, yet the collieries, which are thickly scattered about the district, will probably amply repay the expense incurred in constructing the line and opening the exchange there. The large amount of business done between Newcastle and Sunderland has necessitated the addition of new wires on the trunk line, and these have been just run successfully. It is proposed to establish telephonic fire alarm stations on a novel plan at various points in Newcastle and Sunderland, and it seems quite time that this was done in all large towns.

The Bell Telephone Patent.—The American newspapers are now re-publishing from our columns the letter which Professor A. Graham Bell wrote to Attorney-General Garland, in October last, in relation to the Memphis suits to invalidate the Bell telephone patent.

Telephonic Transmitters.—We have received from America a sketch and description of a telephonic transmitter which was filed for Mr. Barney on August 16th, 1884, No. 11,364, but which he afterwards abandoned. For the benefit of our correspondent "Combination" and the public generally, Mr. Barney submits the same as being without a diaphragm, and under the circumstances, therefore, free to all. It consists of rods of carbon resting loosely in holes in carbon blocks attached to a frame. This frame, although in our opinion no more a diaphragm than the wooden frame surrounding a school boy's slate, brings the apparatus within the Edison specification, (see Mr. Justice North's recent judgment in the case of the U. T. Company *v.* Bassano), and it is therefore useless for us to do more than make a note thereon.

The Carbonisation of Iron.—In the course of a series of lectures on "Impurities in Metals," delivered at the Royal Institution, Prof. Chandler Roberts-Austen performed the experiment of turning malleable iron into steel by means of diamond dust, in such a way that it should be visible to all present. He took the glass vessel, A, B, in which descended



the battery terminal wires, E, E, connected at the ends by the loop of fine malleable iron wire, H. The little vessel, K, below contained diamond dust. The loop, H, was then made white hot by an electrical current, and brought into contact with the diamond dust, K, when it at once fused into globules, where the contact was established.

The Yacht "Kriemhilda."—Mr. A. C. Boothby informs us that this vessel, which we mentioned last week as being electrically lighted, is the property of Mr. H. A. Fergusson, the chairman of the Standard Electric Light Company.

Self Induction.—We are sure that the critical comments on the recent experiments of Prof. Hughes from the pen of Prof. H. F. Weber will be earnestly studied by our readers. This is by far the most important criticism which has yet appeared.

Electricity in the Royal Navy.—The latest addition to the elaborate electric fittings on board the torpedo ram *Polyphemus* is the electric light flashing semaphore which supersedes the Colomb flashing signals, the latter taking too long to spell messages. The electric semaphor is looked upon as a great advance, and the *Polyphemus* was consequently ordered round to Devonport from Portsmouth in order that the Signal Committee sitting at the former port might have a full opportunity of witnessing its working and putting the advantages which are claimed for it to a practical test.

Minimum Waste and Maximum Economy. — In answer to criticisms made in the discussion on Professors Ayrton and Perry's paper on "Economy in Electrical Conductors," recently read at the Society of Telegraph Engineers, they have sent us a contribution on "Minimum Waste and Maximum Economy," published in our columns this week. In this contribution they show that in many cases the most economical conditions of working cannot be arrived at by following the method originally employed by Sir William Thomson, which consisted in considering how to make the waste a minimum, and that a different method must be adopted which, in the case of long lines worked with not very high differences of potential, leads to totally different results.

Fatal Accident with an Electric Gun.—The City Coroner, on Monday, held an inquest as to the death of Mr. Charles Smith Seyton, 63, late of Preston Lodge, Walton-on-Thames, who was found shot through the heart at his office, George Yard, Lombard Street, City, on Thursday afternoon last week. The evidence showed that the deceased was an engineer, and was, in connection with Colonel Reynolds, introducing a system of electric firing of small arms, the invention of Dr. Russell, of the United States. This system was described in the REVIEW of March 26th last. A fortnight ago, in the absence of Colonel Reynolds, he read a paper upon electric firing at the United Service Institution. He was frequently experimenting with firearms in his office. On Thursday afternoon a youth named William Jackson, employed at an adjoining office, heard the report of firearms. It was followed immediately afterwards by a groan. On entering the place the youth discovered the deceased lying face downwards on the floor of his office. A doctor was sent for, but Mr. Seyton was dead. A bullet had entered the chest on the left side, passed through the heart, and lodged in the back. It was shown that the deceased, when experimenting with the firearms, several of which were found in his room, used dummy cartridges, and an opinion was expressed that by mistake he put a live cartridge in the rifle. One witness stated that he thought it was a marvel that the deceased was not shot before, as he was continually experimenting with firearms. A verdict of "Accidental death" was returned.

Gas Engine and Dynamo.—To meet the requirements of electric lighting on a small scale Messrs. Crossley Brothers, Limited, have brought out a small plant consisting of a vertical gas engine of 5 man-power combined with a dynamo, which is arranged to be driven by friction. The engine is of the vertical type, which the firm has been making for some time past, and is practically identical with the better known horizontal pattern, with the exception of such modifications as are

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required by the change of form. Running at 200 revolutions per minute the engine gives 1·3 indicated horse-power and ·98 brake horse-power; at 250 revolutions it gives 1·15 brake horse-power. When running light the indicated horse-power is ·3. The dynamo is of the Jones pattern. It runs at 2000 revolutions per minute, and will feed from six to eight lamps of 20 candle-power each. It is driven by a friction pulley which runs in contact with the fly-wheel of the engine.

The Telephone and the Recent Riots.—During the recent riots in London the United Telephone Company was enabled to warn some of the banks in time for precautions to be taken by the latter.

A Telephone Contest.—A contest between two telephones was carried out at the offices of the Northern District Telephone Company, Limited, Sunderland, a few evenings ago, the types used being the "loud-speaking telephone" and the Blake transmitter and Bell Telephone Combination, the latter being supplied by the Northern District Company. The experiment, according to a local newspaper, amply demonstrated the superiority of the latter instruments over the "loud-speaking" ones, as conversations were carried on with much greater ease, and songs and recitations were heard more distinctly than was the case with the "loud-speakers." We understand that the Northern District Company is making very rapid progress, and that the Tyne and Wear will shortly be in speaking communication with Durham, Darlington, the Hartlepools, Stockton, and Middlesbrough.

The Revenue Returns.—Both the Post-office and the Telegraphs have maintained an elasticity which is remarkable alongside the evidence which other branches of revenue afford that the business of the country is non-progressive. Not only are the Post-office returns improving quarter by quarter, but the total loss to the Telegraph Revenue is but £20,000 for the entire year, notwithstanding the adoption of sixpenny telegrams, so that both these sections of the national receipts must be held to have more than fulfilled expectations.

Colonial and Indian Exhibition.—On the morning of March 29th, H.R.H. the Prince of Wales, Executive President of the Royal Commission, accompanied by H.R.H. the Duke of Connaught, a Royal Commissioner, visited the various sections of the Colonial and Indian Exhibition. Sir Dighton Probyn, Colonel Ellis, Mr. Francis Knollys, and the Hon. Major Egerton were in attendance. Sir Philip Cunliffe-Owen, the Secretary to the Royal Commission, received their Royal Highnesses, and conducted them over the buildings.

Her Majesty the Queen has been graciously pleased to intimate her intention of opening the Exhibition on Tuesday, May 4th.

The proprietors of the *European Mail* and the *Colonies and India* will publish, contemporaneously with the opening of the Colonial and Indian Exhibition in May next, a popular illustrated guide.

Charging Secondary Batteries.—A friend has asked us how Sir Thomas Bazley when charging his secondary battery, can obtain, with the dynamo running at a given speed, a rise in both E.M.F. and current. It has usually been observed that increased E.M.F. corresponds with diminished current.

Liverpool Free Public Library.—We are glad to see that the committee of this library is able to report "continued usefulness and steady progress." The annual report contains a long list of periodicals of multifarious character which are taken, and the enumeration of donations of books and other desirable acquisitions extends to gratifying length.

Electrical Conductors.—We have received specimens of electrical conductors for a variety of purposes, manufactured by the United Electric Wire Company. Leads for electric lighting is the special feature of the company's business, and arrangements are now being made for an extension of the plant for producing the same.

Protection of Submarine Cables.—The International Conference relative to the application of the treaty of March, 1884, respecting the protection of submarine cables, will, states the *Times* correspondent at Brussels, be opened at Paris on May 3rd.

Select Committee on Electric Lighting Bills.—It is proposed to refer the Electric Lighting Bills, introduced respectively by Lord Rayleigh, Viscount Bury, and the Government, to a Select Committee, composed of Earl Cowper, the Earl of Camperdown, Viscount Bury, Lord Balfour of Burleigh, Lord Rayleigh, the Earl of Crawford and Balcarres, Lord Methuen, Lord Houghton, and Lord Lingen.

Explosion of an Underground Conduit.—The iron conduit of the Sectional Underground Company, of Philadelphia, again exploded in Chicago, a short time ago, as described in the following special to the *New York Tribune:* "There was a terrific explosion of gas at Clark and Madison streets, at 1.30 p.m. to-day, and the huge iron cover of a man-hole went flying through the air twenty-five feet away. The streets were full of teams and street cars, and the side walks in all directions were crowded, and every one was badly startled. The explosion came from the underground conduit of the telegraph and telephone lines, and had been caused by escaping gas, but in just what manner is not yet ascertained. Nobody was hurt."

The Lighthouse Experiments.—Mr. C. T. D. Ackland stated in the House of Commons on Tuesday, that the cost of recent experiments at South Foreland had been about £9,000, which is to be defrayed from the Mercantile Marine Fund. Not only increased efficiency, but economy, are expected to result from the experiments.

Size for an Ocean Telephone Cable.—Prof. Chas. R. Cross, according to exchanges, has computed for the proper size of conductor for a transatlantic telephone cable. The copper conductor should be not less than 6 inches in diameter, and the insulating covering of the least electrostatic capacity should be 2 feet thick.

Lectures on Electric Lighting.—Last week Mr. A. P. Trotter lectured at Halifax on "Recent Improvements in Electric Lighting," and took occasion to attack the terminology in general use. "Electric current," he said, was more convenient than accurate, whilst "electromotive force" was altogether an abomination. The lecture proved interesting, and Mr. Trotter was rewarded by the applause of a large audience.

A lecture was given on the subject of electric lighting on Monday evening in St. Mary's Schoolroom, Isleworth, by Mr. P. J. Kelly, A.S.T.E. The experiments were numerous and successful, and the lecture was evidently appreciated by the audience. The apparatus was kindly lent for the occasion by Messrs. Woodhouse and Rawson.

The Joel Dynamo.—We recently visited Messrs. Slatter's works at Dalston, and there saw a dynamo built upon the design of Mr. H. F. Joel. The machine is of substantial construction, the axle being of steel, with phosphor bronze bearings. The armature is constructed in the special manner which we have already described in the REVIEW, namely, with detachable coils. The commutator is of an unusually large size, and the brushes and connections of the armature are very open and easily got at. It is supposed nominally to be a 6 unit machine at 850 revolutions per minute; but the inventor states that it can be made to produce 8 units. Its electrical efficiency has yet to be tested.

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Cable Broken.—The submarine cable between Port Hamilton and the mainland has been broken. Our readers may remember that this cable was laid quite recently, for strategic purposes, when trouble was expected with Russia. It is to be regretted that the cable has not lasted longer.

NEW COMPANIES REGISTERED.

E. T. Syndicate, Limited.—Capital, £6,000 in 40 shares of £150 each. Objects: To acquire and work the British patents for the Immisch motor and Tatham's secondary batteries, and to carry on business as manufacturers and contractors for the supply of electric power of all kinds. Signatories (with one share each): J. Hubel, Rose Villa, Rochester Road, N.W,; R. Macpherson, Cricklewood; F. M. Jones, Perren Street, Kentish Town; E. F. Hunt, 16, Goldsmith Gardens, Acton; W. E. Slaughter, Streatham; C. T. Whinney, 21, Francis Street, W.C. The signatories are to nominate the first directors. Messrs. William David Gooch and William Lyster are appointed engineers to the company. Registered 3rd inst. by Ashurst, Morris, and Co., 6, Old Jewry.

Smith and Chamberlain, Limited.—Capital £100,000 in £10 shares. To acquire the business of Mr. Arthur Chamberlain, of Birmingham, brass founder in all branches, including the manufacture of gas, water, steam, and electric light fittings, lamps, and appliances. Signatories (with one share each): Walter Chamberlain, Harborne Hall, Stafford; Arthur Chamberlain; Miss Agnes Sloane; J. Brown; A. S. Bowler; Richard Chamberlain, M.P.; and Herbert Chamberlain, all of Birmingham. Mr. Arthur Chamberlain is appointed sole director. Registered 5th inst. by Field, Roscoe, and Co., of 36, Lincoln's Inn Fields, acting as agents for Barlow, Smith, and Pensent, of Birmingham.

Westminster Joint Stock Syndicate, Limited.—Capital £3000 in £1 shares. Objects: To subscribe or to advance money, on account of shares in companies for the construction, laying down, and working of submarine or underground telegraph or telephone cable, or other manufacture in which India rubber, gutta percha, or analogous gum is used. Signatories (with one share each): *W. Wood, 13, Delahay Street, S.W.; *Major H. Cotton, 28, Ampthill Square, N.W.; *A. H. Huth, Bolney House, Ennismore Gardens; J. Findlater, 33, Wellington Street, Strand; Surgeon-General W. Munro, 64, West Cromwell Road, S.W.; F. H. Hendre, 11, Delahay Street; T. Kent, 1, Wroughton Road, Nightingale Lane, S.W. Directing qualification, 125 shares. The subscribers to whose names an asterisk is prefixed are the first directors; remuneration, 10 per cent. of the net profits after deducting all charges. Registered 6th inst. by Walter Wood, 13, Delahay Street, Westminster.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hirsch Greystock & Co., Limited, (Portable Electric Light Manufacturers).—An agreement dated 4th ult., and filed on the 1st inst., provides for the purchase by the company of the business of Mr. Walter Moser, of 11, Queen Victoria Street, electrician. The purchase consideration is 1,000 fully paid-up shares of £10 each.

Brighton Electric Light Company, Limited.—The statutory return of this company made up to the 29th ult., was filed on the 3rd inst. The nominal capital is £25,000 in £5 shares. The number of shares taken up is eight of £5 fully paid, and 1,600 of £3 15s. paid, upon the latter 15s. per share has been called. The calls paid amount to £1,240. Registered Office, Gloster Road, Brighton.

Electric Locomotive and Power Company, Limited.—An extraordinary general meeting of this company was held on the 10th ult., at 6, Gt. Winchester Street, when it was resolved that the following alterations be made in the article of association. "In article 8, the words 'provided that no portion of the said capital of £50,000, exceeding £40,000 or of such increased capital shall be raised on shares issued therefor, except with the consent of all the directors, whether present at a board meeting or not, such consent to be signified by the signatures of such directors to the resolutions authorising such raising or issue as aforesaid' be cancelled. In article 9, 'and subject as aforesaid' be cancelled. That the following be substituted for article 45. 'The directors may at any time accept from any member on such terms and conditions as shall be agreed, the surrender of his shares, or any part thereof, whether fully paid or not, and any share so surrendered shall be deemed to be the property of the company, and may be disposed of for the benefit of the company in such manner as the directors may think fit.'" These resolutions were confirmed on the 27th ult., and duly registered on the 2nd inst.

Electric Manufacturing Company, Limited.—At an extraordinary meeting of the members of this company on the 22nd ult., it was proved that the company by reason of its liabilities cannot continue its business, and it was resolved to wind up voluntarily. Messrs. Hugh Erat Harrison, Hy. Newsome Myers and James Bryde McClurg were appointed liquidators. The resolution was duly filed on the 30th ult.

Varley Electric Patents Proprietory, Limited.—At an extraordinary general meeting of this company held at Park Works, Balls Pond, Islington, on the 31st ult., it was resolved to wind up voluntarily, it having been proved to the satisfaction of the meeting that the company could not by reason of its liabilities continue its business. Mr. F. H. Varley is appointed liquidator. The resolution was duly registered on the 1st inst.

Liverpool Electric Supply Company, Limited.—The annual return of this company, made up to the 29th ult., was registered on the 1st inst. The nominal capital is £200,000 in £5 shares; 2070 shares have been taken up, and £4 per share has been called thereon. The calls paid amount to £8,280, being £4,256 in excess of last year's return.

CITY NOTES, REPORTS, MEETINGS, &c.

The Indo-European Telegraph Company, Limited.

ACCORDING to the Directors' report for 1885, the company's revenue from all sources for 1885 amounted to £116,150 3s. 1d. as compared with £98,103 11s. 9d., showing an increase of £18,046 11s. 4d., or rather more than 18 per cent.

The expenses were: on commercial and general account, £26,509; on maintenance account, £25,088 8s. 11d., including £145 5s. 11d. paid to the Russian Government; total, £51,597 8s. 11d., as against £53,323 19s. 6d., a decrease of £1,726 10s. 7d. This is owing to the exceptional outlay on the duplicate Kertch Cable which appeared in last year's accounts. The maintenance expenditure, however, includes the cost of alterations and improvements in the company's lines. On commercial account there is an increase of £1,637 7s. 7d., mainly occasioned by staff for additional through circuits and the expenses attendant upon the increased business done.

Deducting the above expenses, taking credit for £4,578 11s. 7d. balance brought over from 1884, and debiting income tax, there remains the sum of £67,456 5s. 1d.

From this amount £10,625 has already paid for interim dividend, leaving a balance of £56,831 5s. 1d.

The Directors, after setting aside £15,000 to the reserve fund, propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 30s. per share, both free of income tax, making in all 12 per cent. for the year, and carrying forward £1,456 5s. 1d. to the credit of 1886.

The extra cable circuit by the new agreement with the Post Office, and the other additions made out of revenue to the

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company's system, aided by the second wire granted by the German government, by which two special circuits are secured frome London to Teheran, continue to prove of great advantage to the working of the company's system.

The above improvements have also contributed to enable the company to deal satisfactorily with the additional business thrown upon the lines during the past year.

The large augmentation of revenue is quite exceptional and is owing to the total interruption of the Eastern Company's lines for some three weeks, the disturbances in Burmah and the Afghan Frontier question, and it is satisfactory that the £18,046 11s. 4d. of additional revenue has only occasioned an increased expenditure on commercial account of £1,637 7s. 7d.

At the Telegraph Conference of Berlin, in response to the desires expressed by the Indian Government and the German Postmaster-General, his Excellency Dr. von Stephan, it was determined to reduce the rate to India from the 1st of July next from 4s. 7d. to 4s. per word. This will cause a diminution of the company's revenue, but the Board were of opinion that the time had come for a material reduction in the tariff.

Reductions were also arranged for, to Australia and China, the amounts of which are not yet fixed, to take effect from the same date.

The Eastern Extension, Australasia and China Telegraph Company, Limited.

THE Report and accounts of the directors for the half-year ended 31st December, 1885, state that the gross receipts, inclusive of Government subsidies, have amounted during that period to £247,017 6s. 4d., against £248,087 19s. 5d. for the corresponding half-year of 1884.

The working and other expenses, including £27,236 16s. 1d. for cost of repairs to cables and expenses of ships, absorb £71,473 6s. 9d. against £79,496 9s. 1d. for the corresponding period of 1884, leaving a balance of £175,543 19s. 7d. From this is deducted £3,763 2s. for income tax, £41,595 for interest on debentures and contributions to sinking funds, leaving £130,185 17s. 7d. as the net profit for the half-year, which, with £32,858 6s. 11d. brought forward from the previous half-year, leaves a balance of £163,044 4s. 6d. Against this the balance of cost of the Singapore-Saigon and Penang-Rangoon Cable Renewals, the cost of duplicating the Victoria-Tasmania cable, and the cost of connecting and establishing a cable station at the North Saddles (China), amounting altogether to £36,076 2s. 1d., have been charged.

One quarterly interim dividend of 1¼ per cent., amounting to £31,250, has been paid for the half-year, and it is now proposed to distribute another of like amount, together with a bonus of 2s. per share payable on the 15th inst., making, with the interim dividends and bonus paid for the first half-year, a total distribution of 7 per cent. for the year 1885. The balance of £39,468 2s. 5d. has been carried to the general reserve fund, which now stands at £565,644 6s. 1d.

In pursuance of the conditions upon which the issue was made, 102 of the company's 5 per cent. debentures of 1880 were drawn by lot on the 15th ultimo for payment at par on the 1st May next.

The new cable steamer "Recorder," referred to in the last report, has arrived at her station at Singapore, and the steamship "Agnes" has left for England to be overhauled for requisite repairs. The cost of the "Recorder," amounting, with cable machinery and Electrical Apparatus to £42,606 14s. 2d., has been deducted, as shown in the balance-sheet, from the maintenance ships' reserve fund.

The cable between Victoria and Tasmania has been duplicated during the half-year under review out of the company's stock of spare cable at Singapore, and the cost (£31,190 5s.) has been charged, as above stated, against revenue.

The principal cable repairs during the half-year have been on the Java-Australian and Penang-Singapore sections, but the communication has been uninterruptedly maintained by means of the duplicate lines. All the company's cables are now in good working order.

In consequence of the frequent interruptions of late years to the Penang-Singapore (original) cable resulting in a large annual expenditure for repairs, your directors have determined to replace it with a new cable of brass-ribboned type, and a contract has been entered into with Telegraph Construction and Maintenance Company for carrying out the work. It is anticipated that a large proportion of the old line will be picked up, and after it has been overhauled and re-served will be available for extensions or renewals in other directions.

Your directors regret to report that their efforts to induce the Indian Government to lower the transit rate for international messages across India have been unsuccessful. As, however, the Australian Colonies were, at Berlin, led to expect some reduction in the cable charges, the company, after consultation with the agents-general, and notwithstanding the refusal of the Indian Government to participate in the reduction, have decided to reduce the tariff from the 1st July next by 1s. 4d. per word unconditionally, and to make a further substantial reduction provided the Colonies agree to certain conditions proposed by the company. It has also been decided to reduce the tariff between Europe and China from 8s. 4d. to 7s. 1d. per word, to take effect from the same date.

The South Australian Goverment land line between Port Darwin and Adelaide has, as usual, been well maintaned during the past half-year.

Great Northern Telegraph Company.—The accounts for 1885 show that the revenue, including £31,338 brought forward, amounted to £328,636. The total expenses were £85,136, and, provision being made for interest on and amortisation of debentures, there was a surplus of £118,436, for which an interim dividend of 5 per cent. has been paid, and an extra dividend of 3 per cent. £55,555 has been added to the reserve and renewal fund, the net amount of which is now £417,448; £2,777 has been added to the pension fund of the staff; and £29,533 has been carried forward.

Anglo-American Telegraph Company, Limited.—The Board has resolved, after placing the sum of £25,000 to the credit of the renewal fund to declare an interim dividend for the quarter ending March 31st, 1886, of 5s. per cent. on the ordinary stock and 10s. per cent. on the preferred stock, less income tax, payable on May 1st to the stockholders registered on the books of the company on March 31st, 1886.

The Direct United States Cable Company, Limited.—The Board has resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ending March 31st, 1886, such dividend to be payable on and after the 24th inst.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of March was [illegible], estimated to produce £3,300, against 4,121 messages, producing £3,510 in the corresponding month of last year. The receipts for the month of December, estimated at £2,450, realised £2,448.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 2nd, were £2,482, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for March, 1886, were £20,000; from January 1st to March 31st, 1886, £58,680; in the corresponding month of 1885, £64,400; and of 1884, £60,600.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for March amounted to £37,804, against £46,193 in the corresponding period of 1885.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of March were £1,751, against £1,467 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for March amounted to £53,016, against £68,296 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending April 2nd, amounted to £3,076

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending March 31st were £3,525.

NEW PATENTS—1886.

4491. "Incandescent electric lamps." F. SCHAEFER. Dated March 31. (*Complete.*)

4492. "Novel adjustable electric lamp." G. H. SALVAGE. Dated March 31.

4522. "Process of utilising the spent liquid from certain voltaic batteries." W. S. SQUIRE. Dated March 31.

4523. "Induction apparatus, or secondary generators." H. Müller. Dated March 31. (*Complete.*)

4533. "Electric flash signalling apparatus." E. S. BRUCE. Dated March 31.

4555. "Distribution of and apparatus for transforming continuous electrical currents." A. LE N. FOSTER, F. V. ANDERSEN. Dated April 1.

4575. "Secondary batteries." W. J. S. BARBER-STARKEY. Dated April 1.

4584. "Operating switches." C. BROWETT. Dated April 1. (*Complete.*)

4630. "Stranded electric conductors." E. W. LANCASTER. Dated April 2.

4634. "Tension regulators for telephones, &c." G. A. NUSSBAUM. Dated April 2.

4660. "Apparatus for altering the potential of electrical currents." J. D. F. ANDREWS. Dated April 2.

4662. "Automatic electrical distribution and charge of secondary batteries." F. KING. Dated April 2.

4663. "Electric generators." F. F. Stögermayr, V. GLASSNER. Dated April 2.

4751. "Application and utilisation of magnetism or electro-magnetism for the separation of metals and for other purposes and apparatus therefor." H. S. MAXIM. Dated April 5.

4755. "Switches for making or breaking electric circuits." R. CORNTHWAITE, R. INGHAM. Dated April 6.

4796. "Arc lamps." R. KENNEDY, R. DICK. Dated April 6. (*Complete.*)

4799. "Galvanic finger rings, bracelets, necklets, anklets, &c." W. SCHULLER. Dated April 6.

4809. "Electric furnaces." W. P. THOMPSON. (Partly communicated by the Cowles Electric Smelting and Aluminium Company.) Dated April 6.

4810. "Electrically controlled lock." W. P. THOMPSON. (Communicated by M. Gillet.) Dated April 6.

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ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3115. "Improvements in the manufacture of carbon filaments for incandescence lamps." R. Dick. Dated March 10. 6d. The inventor forms carbon filaments from strands of silk, cotton, or other fibrous substances, or from strips of paper or parchment or of woven fabrics, or of other materials commonly employed for the purpose, which strands or strips he encloses within tubes of copper, or other soft and ductile metal, which afterwards draws down through dies or otherwise to reduce the diameter of the tubes and thereby to compress the materials within them. The strands or strips may either be enclosed within solid tubes, or the tubes may be formed round or partially round them out of flat or channelled strips of metal. The compressed filaments thus formed are then cut into suitable lengths, and bent or shaped to the desired form, and are carbonised in the ordinary way. After carbonisation of the filament the copper tube or other metallic coating is removed from the greater part of its length by immersion in nitric acid, or by electrolysis, or by other well-known means, the metallic coating being however left at the ends to serve as a convenient means of connecting the filament to the conducting wires of the lamp by soldering, screwing, or clamping.

3121. "Improvements in and apparatus for transmitting rotary motion to dynamo-electric machines, which improvements and apparatus are also applicable to transmitting rotary motion from electro-dynamic machines." H. Lindley. Dated March 10. 8d. The inventor mounts a disc or plate upon the axle or shaft of the steam-engine, or other motor above mentioned, and in the face of the said disc he forms grooves or slots, which grooves or slots extend across the face of such disc—the armature and other revolving parts of the dynamo-electric machine he places so that the axis thereof is parallel to the axis of the shaft or axle of the steam-engine or other motor above referred to—upon the shaft or axle of the armature and other revolving parts of the dynamo-electric machine he mounts a disc plate or arms, secured to which disc plate or arms are pins or studs, upon which pins or studs are or may be mounted bowls rollers or blocks, which pins, studs bowls, rollers or blocks pass into the grooves or slots formed in the disc or plate previously mentioned, and are acted upon by the sides of such grooves or slots.

3212. "Improvements in dynamo-electric machines and in electro-motors." G. Hookham. Dated March 12. 8d. Relates to improvements in the cylindrical armature described in specification No. 7533, 1884, having longitudinal grooves or slots in which the conductor is wound, and so arranged that the sum of the sectional areas of the ribs or ridges at one time under a pole piece of the field magnets is equal or nearly equal to the magnetic section of the rest of the armature.

3247. "Improved instruments for determining or measuring electric currents and electromotive force." O. March. Dated March 12. 6d. The primary object of the invention is to produce instruments for measuring electric currents which shall not only be direct reading, but also have a wide range of reading; be easy of calibration and inexpensive to manufacture.

CORRESPONDENCE.

Electric v. Oil Lamps.

My remarks at the Society of Arts on the above subject have been misquoted, and your correspondent, Mr. Cotterill, has been thereby misled.

What I did say was, that the comparative tables of cost given in Mr. Edwards's paper on Lighthouse Illuminants were hardly fair to the electric light, as they were made out on the supposition that an electric light of enormous C.P., 20 times as powerful as that given by the 108 ring gas burner, must be used at all times whether such an enormous light were required or not. I said that by proper arrangement an electric light could be furnished for lighthouse pnrposes which could be easily adjusted so as to give a sufficient light for ordinary clear weather, but which could be increased to any desired extent up to and even exceeding the enormous lights shown at the Foreland, and that the result of this modification would be that whereas the Lighthouse Illuminants report shows that the electric light costs two-and-a-half times as much as oil does, it need only cost one-and-a-half times as much as oil. The report on Lighthouse Illuminants to which I refer estimates the cost of an electric light station with single light having double power for fogs at £17,749, and the cost of maintenance at £1,927 per annum, whereas the corresponding figures for an ordinary first order oil lighted tower are £8,064 18s. 3d. and maintenance £724 4s. 7d. per annum. I propose to reduce the maintenance of the electric lighting station from £1,927 to £1,100. 1st. By providing for ordinary lighting in clear weather a group of 14 50-C.P. incandescent lamps and arranged in a close cylinder, and not occupying a greater space than the present Douglas 6-wick burner. For thick weather I propose to substitute a powerful direct current arc light, the full advantage of which could be best obtained by using a catoptric arrangement instead of the dioptric one hitherto employed for alternating current lamps. This catoptric arrangement would necessitate a revolving or partly revolving light, and as electricity is most likely to be used on headlands on the main land the beam need not revolve or oscillate through the entire circle. I know there is no difficulty in working out the practical details of such an arrangement as I have here briefly sketched out. The electric current for the incandescent lamps or for the large arc lamps can be supplied with the greatest certainty and steadiness from accumulators which could be charged by a comparatively small combined steam engine and boiler, or where gas works are accessible, by means of a gas engine. In this way the extremely heavy charges of £800 a-year for wages, coke, oil and carbons, as estimated in the report might be reduced fully one-half. The first cost of the plant, hence the charge for depreciation and renewals, would be greatly reduced. I will not occupy more of your valuable space by going into details. I think I have said sufficient to show that a strong case may be made out for the economy as well as the efficiency of electricity employed as a lighthouse illuminant.

R. E. Crompton.

Mansion House Buildings,
London, *April 1st*, 1886.

Proofs that Electricity is an Element.

In 1882 I published* the particulars of some experiments which led to the conclusion that electricity is a kind of matter which, although it does not gravitate, yet seems to be the medium of gravitation in common matter. I hope you will allow me to lay before your readers some facts which establish the accuracy of the foresaid conclusion.

1. Prof. Dewar has proved that oxygen gas is a transparent, colourless fluid when exposed to a temperature of — 130° C., and under a pressure of between 80 and 100 atmospheres, and also that liquid oxygen does not act on sodium, potassium, phosphorous, hydrogen, and other re-agents.

2. MM. Hautefeuille and J. Chappius proved by experiments that ozone, at the temperature of — 23° C., and under a pressure of 75 atmospheres, is a liquid of an azure blue colour.

3. All the modern books on chemistry assert that ozone is condensed oxygen.

4. Prof. Dewar found that the low temperature of — 130° C., and pressure of 80 to 100 atmospheres, was incapable of condensing oxygen into ozone. Therefore something still more powerful is required in order to condense oxygen into ozone.

5. According to all modern books on chemistry, three volumes of oxygen gas are condensed into two volumes by their conversion into ozone, namely, that "ozone is oxygen existing as a triatomic molecule." Is this the truth ? Yes ; but it is not the whole truth. It takes something more than oxygen to make ozone ; but this something is not allowed to have an existence according to books on chemistry.

6. When a frictional electric machine is set in motion, the peculiar smell which arises is caused by the free electricity acting on the oxygen of the air, and converting it into ozone. And when scientists wish to make ozone in considerable quantity they pass

* The *Engineer*, Vol. LIII., p. 360. The *Electrician*, Vol. IX., p. 63.

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oxygen gas through a tube, which is electrified positively, namely, at that which is called a high potential, and the gas which goes in at one end of this tube as oxygen comes out at the other end in the form of ozone. In other words, a supply of electricity is required to condense oxygen into ozone.

7. If ozone gas be shaken within a glass vessel containing some powdered glass, the electricity which the oxygen had absorbed to convert it into ozone leaves the ozone and goes into the powdered glass, and the ozone expands into and becomes oxygen gas. This process of making a portion of oxygen gas to alternately condense into ozone, and again expand back into oxygen, by alternately adding and subtracting the necessary quantity of electricity, may be carried on indefinitely. In other words, we can make ozone synthetically by adding an element to oxygen, and we can decompose ozone analytically by subtracting the said elements. Yet, according to all the books on chemistry hitherto published, the element in question is not granted to have any existence. It is looked upon as being merely a mathematical quantity.

8. Look, now, at the enormous difference there is between oxygen gas condensed into ozone by means of electricity, and oxygen gas converted into a liquid by the low temperature of — 130° C., and a pressure of from 80 to 100 atmospheres. The oxygen condensed by the means of adding electricity acts with enormously increased powers on all the ordinary re-agents, and it acts so powerfully on such substances as vulcanised India rubber, that if a tube of it be used to pass ozone gas through, the ozone soon destroys the tube; but oxygen alone cannot do this, and when oxygen is condensed into the liquid state by low temperature, combined with enormous pressure, it loses all its power to act on the common re-agents, on which it acted so well when in the gaseous state. Why is this? When oxygen is condensed into ozone it is by means of electricity added to it; whereas, when oxygen is converted into a liquid by low temperature and great pressure, there is good reason to believe that the amount of electricity which the oxygen held in the latent form while it was in the gaseous state is crushed out of it in order that the oxygen might go into the liquid state, and that it is the reduced quantity of electricity within the liquid oxygen which makes it incapable of acting on the common re-agents.

Although it is undoubtedly the extra amount of electricity which becomes latent within the oxygen and converts it into ozone and gives the latter its increased power of acting on reagents, yet scientists won't admit that ozone is a compound of electricity and oxygen. Their theory which asserts that electricity is a nonentity, is contradicted by the foregoing facts.

Maxwell wrote, in his "Elementary Treatise on Electricity," page 8, "The analogy between temperature and potential must not be assumed to extend to all parts of the phenomena of heat and electricity." . . . . "We must remember that temperature corresponds to a real physical state, whereas potential is a mere mathematical quantity, the value of which depends on the point of reference which we may choose. To raise a body to a high temperature may melt or volatilise it. To raise a body together with the vessel which surrounds it to a high potential produces no physical effect whatever on the body." Is this true? In order to convert oxygen into ozone, the tube through which the oxygen passes requires to be kept at a high electric potential, and it is because it is so kept that the oxygen passing through the tube absorbs electricity and the oxygen is thereby converted into ozone, which fact is the very opposite of Maxwell's statement that "a high electric potential has no physical effect on the body"—the oxygen.

Although electricity may not gravitate, yet it has the power of causing common matter, such as oxygen, to cohere and condense so that three volumes of oxygen are crushed into two volumes which we call ozone, and hence electricity must be an element.

There is another interesting matter in connection with this subject. When MM. Hautefeuille and Chappius attempted to condense ozone gas into the liquid form they found that the ozone exploded in the glass tube they were condensing it in when the temperature was allowed to rise higher than—23° C., and at the time the explosion occurred a flash of yellowish light appeared within the tube.

These scientists did not attempt to explain these phenomena, but there can be only one cause for the explosion, namely, the sudden decomposition of the ozone; its latent electricity having suddenly left it, the two volumes of ozone would instantly become three volumes of oxygen, hereby producing the explosive force. Now arises the question, What induced the latent electricity to leave the oxygen? As the rise of temperature was the primary cause of the explosion, it must have been the increased quantity of heat within the tube which attracted the latent electricity and took it away from the ozone, and if so, then we know that it must have been the union of the extra heat with the latent electricity which produced the flash of light within the tube.

James Johnstone.

8, Merchiston Park, Edinburgh,
April 2nd, 1886.

Secondary Generators or Transformers.

Although we consider the newspaper discussion in reference to Messrs. Zipernowski, Deri, and Blathy closed as far as we are concerned, we cannot allow the claims described in their letter of the 18th ult. to pass without protest, and we declare for the last time that we shall not allow anyone to employ secondary generators or transformers of any model or under any conditions for the purpose of distributing electrical energy.

L. Gaulard.
J. Dixon Gibbs.

18, Warwick Street,
Regent Street, W., *April 6th*, 1886.

[At the time the apparatus of Messrs. Gaulard and Gibbs was first exhibited at the Royal Aquarium we pointed out what previous workers had done in the direction of distributing electrical energy by means of induction coils, *alias* secondary generators, *alias* transformers. We do not think, therefore, that our correspondents quite appreciate the situation, or they would not publish such an absurdity as the threat contained in the above communication.—EDS. ELEC. REV.]

Mechanical Telephones.

A man representing himself as an agent of the Telephone Companies called on me respecting a mechanical telephone I have in my place, and threatened me with proceedings unless I removed same. Will any of your contributors inform me whether there is the least ground for any such act on the part of anyone, be he Postmaster-General, secretary of telephone company, or what not?

"Iron."

[The Telegraph Acts have been held to cover the electric telephone, and, as the wording of the clauses of those Acts does not confine their application to electrical methods, but mentions "electric or other telegraphs," and "any cables, apparatus, pneumatic or other tube, pipe, or thing whatsoever used for the purpose of transmitting telegraphic messages," we are inclined to the opinion that the Postmaster-General would claim jurisdiction over any public mechanical system. "The Telephone Companies" certainly have nothing to do with the matter, if by the phrase is meant, as we surmise, the United Telephone and its subsidiary companies. If our correspondent's telephones are only used for private purposes we see no reason for the interference of any person.—EDS. ELEC. REV.]

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The Efficiency of the Edison-Hopkinson Dynamo.

I presume that Mr. Walmsley, in the letter published in your last issue regarding the recent tests made by Messrs. Mather and Platt on the efficiency of the Edison-Hopkinson dynamo, refers to the balance of loss unaccounted for after deducting the known losses in the magnets and armatures of the generator and motor respectively from the total loss as determined by the dynamometer. In the calculation published in your issue of March 5th, this was divided equally between the generator and motor, for which there is good reason, on theoretical grounds, on which I do not now propose to enter. The total amount in question is only 831 watts, out of 42,917 watts developed, and, if divided between the two machines in any other proportion, the effect would be merely to increase or diminish the efficiency of the generator by some fraction of 1·94 per cent. and to diminish or increase the efficiency of the motor in the same ratio.

Edward Hopkinson.

Salford Iron Works,
April 1st, 1886.

Secondary Batteries as Regulators.

Mr. Sellon's remarks bear out my theory, stated in other words, but his arguments apply only to special cases, and one of his conclusions is erroneous. Clearly, if the cells being fully charged, and then the lighting circuit used (no current flowing to the cells at the time), were sufficient by itself to regulate and such regulation remain with more or less lamps on, then a small accumulator would suffice for any sized installation, but such is proved by theory and practice not to be the case. Mr. Sellon's experiments appear, from his description, to have been limited to cells used with small dynamos, and probably with rapidly falling curves. I concur with all his remarks if this condition is inserted, but very different conclusions result if we go outside this.

Mr. Sellon's further remarks on the results to be expected when cells and dynamo share the work, also are only true in special cases. It is not my intention to occupy your space to explain this again, for, in my paper on "Constant E.M.F., &c.," the conditions were fully worked out for all cases.

It is as I have always maintained, regulation is usually obtained by accident, not by design.

David Salomons.

20, Hyde Park Terrace, W.
April 3rd, 1886.

Energy Meters.

With reference to the interesting article in your issue of the 2nd inst, describing Mr. Weston's new Energy Meter, which consists of an electro-motor having its field magnet wound with fine wire, and which is placed as a shunt to the circuit, the electrical energy given to which it is desired to measure, while the armature is traversed by the main current and so rotates, the number of rotations made in a given time, recorded on a counter, being a measure of the total energy as the motion of the armature is resisted by fluid friction from its dipping into a mercury trough, I may remind you that such energy meters have been made and practically used since the commencement of 1882. They are fully covered by claim No. 1 of the patent of Professor Perry and myself, No. 2642 of that year, which states—(1) "In measuring the total amount of energy given to an electrical circuit, the use of an electro-motor whose fixed and movable parts have soft iron or else non-magnetic cores wound respectively with a coil or coils of small resistance through which the main current of the circuit passes, and a coil or coils of high resistance through which passes a current proportioned to the difference of potentials at the ends of the circuit in question, the motion of the motor being resisted by vanes immersed in a fluid or by other resistance which is proportional to the velocity substantially as described."

The Clock energy meter covered by Clause 2 of the same patent, and which was described in your columns last year, in connection with the exhibits at the Inventions Exhibition, is the form that we have preferred to use on account of its greater simplicity, and is therefore probably better known.

W. E. Ayrton.

April 5th, 1886.

Compound Wound Dynamos in Parallel.

We have noticed that, in his recent work on dynamo-electric machinery, Professor Sylvanus Thompson mentions the great difficulty experienced in working compound-wound dynamos in parallel circuit, because of the fact that the slight difference in E.M.F. which is liable to exist between two or more machines will be greatly aggravated until the stronger machine short-circuits through the weaker, and the balance of the system is completely destroyed.

He also states that Mr. W. M. Mordey has pointed out "that the difficulty may be overcome by connecting the parallel machines in such a way that not only are the shunt portions of the field magnets in parallel circuit, but the series circuits of the field magnets are also a shunt on one another; in other words, by connecting the brushes as well as the terminals in parallel circuit."

We think it but just to state that this method of solving the difficulty has long been known to ourselves, and practised in connection with the Thomson incandescent dynamo, made by the Thomson-Houston Electric Company, Lynn, Mass., and that it was finally made the subject of United States patent, dated Oct. 13, 1885, to E. W. Rice, jr., a copy of which patent we enclose.

We have often noticed that the same idea frequently occurs almost simultaneously to different persons pursuing the same line of work, and the present case appears to be but one more interesting example.

E. W. Rice, jr.

Thomson-Houston Electric Company,
Lynn, Massachusetts.
March 24th, 1886.

[We have forwarded the copy of Mr. Rice's patent to Professor Silvanus Thompson for his perusal.—EDS. ELEC. REV.]

The Bassano-Slater Telephone Case.

"L'Homme Qui Rit" in his "plums" has very well put some of the extraordinary reasons given by Mr. Justice North, and which caused considerable astonishment to many who heard his Lordship deliver the same. Unquestionably it is one of the most marvellous contributions we have yet heard upon the subject, and conclusively proves the incompetence of an ordinary legal tribunal to deal with scientific questions.

Will you permit me to give "in his Lordship's own words," one or two instances with the addition of a brief comment.

Mr. Justice North says at the date of Edison's patent (July, 1877, not 1878 as "L'Homme Qui Rit" says) "no mode, by which articulate speech could be reproduced at long distances had yet been worked out."

At last we have legal authority for contending that Graham Bell was not the first inventor of the speaking telephone.

Mr. Justice North says, that according to the specification, the diaphragm or tympans might be "wholly or *partially* across the instrument." The intention in using the word *partially* is obvious to anyone knowing the defendant's transmitter. Now there is not a single instance either in the letterpress or drawings of a diaphragm "*partially*" across the instrument.

He further states that the "red back" was the acting diaphragm in the defendant's instrument, because the defendant's instrument "speaks better when the outside of the red back is addressed than when the voice enters the mouthpiece." I should have thought that the logical conclusion from this was, that when the mouth-

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piece is spoken to, as must be the case in the defendant's instrument when in actual use, the red back was *not* acting as a diaphragm.

The defendants therefore infringe, not because they had a diaphragm—not because in having the red back they were utilising the function of a diaphragm; but because the red back *possessed* the function.

But further, the "tube" and the bell shaped "black base" which holds the carbon blocks and pencils are diaphragms. It matters not what is the obvious intention in their use. If they are capable of vibration they are diaphragms, according to Mr. Justice North. Their shape matters not! It is only a question of degree! It is the *function* that is the diaghragm. Edison claims the function to vibrate possessed by a diaphragm, not a diaphragm whose function is to vibrate! Could absurdity be carried further? Edison makes a most decided disclaimer of general principles or of details, other than the combination of the two details, diaphragm and tension regulator "*substantially as described.*" Separately, he is no more entitled to the diaphragm, than to the tension regulator. Therefore if he is entitled to the function of the diaphragm, he is entitled to the function of the tension regulator, that is, to vary the resistance in a closed circuit pure and simple. But unfortunately for Mr. Justice North's reasoning, Edison states himself, that he does not claim this. Still Mr. Justice North says, his diaphragms differ "in size, *principle*, material, *form*, position and *otherwise.*" Can anyone suggest what description of diaphragm the *otherwise* is, and if it possesses the all important *function?*

Mr. Justice North says, the contention of the defendants could not be maintained "either upon principle or authority." As regards the principle, he says, Edison "discovered a very remarkable *new manufacture*," and indicated several *practicable modes* of carrying it into effect.

We will leave the *practical modes*, with the mere remark, that none of them has ever been in *practical* use. Further, it was not a "*new manufacture.*" It was merely an improvement. The specification itself states, that it is simply for an "*improvement* in instruments for controlling by sound the transmission of electric currents and the reproduction of corresponding sounds at a distance," and the disclaiming clause disclaims the general principle of a new manufacture, and confines itself to two details—disclaiming all others.

However, Mr. Justice North says so, and that consequently, being a *new manufacture*, he need not describe all the modes of carrying it out, therefore (now please observe his Lordship's reasoning), "if the defendants *place a diaghragm* in their apparatus, which performs the *functions* of diaphragm in the plaintiff's apparatus" they infringe, &c.

It is a reversal of his previous reasoning.

In first dealing with the detail he says that anything which performs the *function* of a diaphragm *is* a diaphragm.

In dealing with the principle he says, if there *is a diaphragm* performing the *function* of a *diaphragm*, it is a diaphragm.

Let us hope none will ever be so absurd as to deny the last proposition.

Clearly his Lordship, in here protecting the "principle," has (doubtless unconsciously) murdered the remainder of his reasons. This was the very essence of the defendants' case. A *diaphragm* which "performs the function of a diaphragm" was not present—so much for the principle.

Now as regards his authority,

Mr. Justice North says the "decision of Lord Justice Fry in the case he decided seems to me to cover the present case." That is just what it does *not* do.

There was in that case a partition or separater between the speaker and the carbon, and it pressed upon the carbon when spoken to. It was (although not what Edison meant) "a *diaphragm* performing the *functions* of a diaphragm." But in the present case there was not! Where, therefore, is the authority?

As regards the tension regulator, Mr. Justice North says that Mr. Conrad Cooke said that "hard carbon is not appreciably compressible." Mr. Conrad Cooke said nothing of the kind. What he said was, that when good contact was made with the hard carbon no amount of pressure would appreciably alter its resistance. As regards his Lordship's next assertion, that a billiard ball, "if dropped from a sufficient height," is "compressed to half its diameter." Would some of your readers say how far it would have to drop? Possibly his Lordship means that it would break in half and thus be half its original diameter.

As regards conductivity, his Lordship is wisdom itself. He says, "again it is said that hard carbon is not semi-conductive, because it is a good conductor. But this also is a question of degree." Quite so. It is only a question of degree between a silver wire and a clothes line. But seriously, anyone having a rudimentary knowledge of electrical science cannot misunderstand what Edison meant by semi-conductive. And permit me to say, nothing was made more clear to Mr. Justice North in evidence. It was what one would term a partial conductor powdered (that is, plumbago, lamp black, or metallic oxide (?)) and mixed with an *insulator*, and thus producing when done a "semi-conductor."

Mr. Justice North also says that "Mr. Imray's evidence is clear that there is no difference in operation between the plumbago points there described and the carbon used in the Blake, the Ader, the Gower-Bell, &c." In the first place, Mr. Imray never said he had seen or tried one in operation, and in the second place, he could not if he would. It is impracticable, whatever it may seem theoretically. Those who doubt let them try, as I have.

Dealing with the question of being commercially useful, and having been in practical use, perhaps his Lordship makes the most astounding statement of all, and I give it in conclusion. He said, "There is direct evidence on the subject. Sir William Thomson *proves* that he has seen transmitters constructed in some of the forms Edison described, in actual use, and has himself used them," and that "any one of them could be used as a commercial instrument." Sir William Thomson did not *prove* anything of the kind. He made the assertion that he had seen one in use in Lombard Street, but when challenged by Mr. Bigham he had to admit that it was provided with a hard carbon contact—in fact, a Blake transmitter—only he always considered the Blake instrument was Edison's. So much for Sir W. Thomson's *proof.* On this point his Lordship also says that Professor Forbes stated "He could not say if they would act practically as he had not tried them." How can Mr. Justice North justify this when he has Professor Forbes's own description of two experiments during the trial with the gum rubber-plumbago contact before him, in which he stated he (Professor Forbes) could not obtain the slightest sound? Perhaps the climax of his Lordship's ingenuity and *impartiality* is reached (as it should be) in the last few lines where (because Mr. Conrad Cooke stated that Edison's tension regulators would not work without a diaphragm) his Lordship said, "It was obviously his view that if it was *not taken away* they would act."—What taken away?—The *function* to vibrate or the *diaphragm?*

There are many details in Edison's transmitters, such as resonant tube, box, diaphragm, tension regulators, springs, adjusting screws, &c.—Edison mentions the function of everyone. His diaphragm is to vibrate; but so is his tube. He says, "The vibrations are given either to the resonant tube or deflected to the diaphragm." Edison thus distinctly mentions the fact that the tube will vibrate. Still he disclaims all other details or combination of parts, and claims only the combination of the diaphragm or tympan with the tension regulator. Mr. Justice North says because it performs this function (vibration) it is not what Edison says it is, but something else. His Lordship evidently understands Edison's instrument better than Edison understood it himself.

F. T. H.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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ELECTRICITY IN MINES.

THE years of consideration and experiment bestowed upon the subject of accidents in mines by the Royal Commission appointed for that purpose have at length resulted in the publication of a report which, extending over 120 pages, will yet be read with close and critical interest by more than one class of persons. Though possibly the report will not in all points accord with the views of some who have long been eagerly watching for its issue, we have no hesitation in saying that it will be generally recognised as a valuable contribution to the current knowledge respecting the prevailing conditions beneath the surface of the earth. The interest with which electricians will examine it is due to the fact that a very general idea has arisen that the use of the electric light in mines would conduce greatly to the comfort and safety of the miner. This belief has led to the appearance of more than one form of electric lamp designed for miners' use, and doubtless others are undergoing the process of construction. The report of the Commission brings both hope and disappointment to the electrician, for while it speaks of the advantages in point of convenience and efficiency which attend the employment of electric glow lamps for illuminating the pit's bottom and roadways immediately adjacent, it also points out that, while the portable electric lamps upon which great hopes have been based, are perfectly safe, they do not afford any indication of the condition of the atmosphere in a mine, and that in consequence of this circumstance their employment, even where special fire-damp detectors are used, cannot entirely dispense with the necessity for the use of some other form of safety lamp. The meed of praise accorded to the electric light, however, is not stinted, and it is gratifying to have such eminent testimony to the fact that for exploring purposes after accidents, or in foul places, portable, self-contained electric lamps (such as have been described in the columns of the REVIEW within the last few months), must prove very valuable even in the present condition of their development; as auxiliary lights, the Commissioners add, they cannot fail to prove very useful. They recognise the great progress recently made in the construction of portable electric lamps, and perceive the promise of their speedy utilisation to an important extent in coal mines. With regard to the application of glow lamps to underground illumination through the medium of conducting cables leading from the generators to the pit bottom, it is laid down as essential to safety, as well as to the permanent efficiency of the installation, that the cables should be placed in positions where they would be thoroughly protected against possible accidental injury; and also that in all mines were fire-damp has been known to occur, the glow lamps should be excluded from direct contact with the air of the mine. Looking to the conclusions of the Commissioners, it seems that we must not be too ambitious with regard to mine lighting; and yet they give us very substantial encouragement to persevere in that direction.

Another portion of the Commissioners' report shows that the use of electricity is not exhausted underground when it is applied to illumination, for it states that electrical exploding appliances present very important advantages from the point of view of safety over any kind of fuse which has to be ignited by the application of flame to its exposed extremity, as the firing of shots by their means is not only accomplished out of contact with air, but is also under most complete control up to the moment of firing. Their simplicity and certainty of action have been much increased of late years, while their cost has been greatly reduced, and but little instruction is now needed to ensure their efficient employment by persons of average intelligence. For these reasons the use of electrical arrangements for firing shots in mines should be encouraged as much as possible.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

By CARL HERING.

III.—SHUNT MACHINES.

To determine directly what the current and what the number of windings must be for the assumed thickness, c, of a coil, calculate the diameter of the naked wire from the formula, take the gauge number wire nearest to it, and measure its diameter with the insulation, which is best done by winding closely ten turns around a pencil or bolt, and measure the length of this little coil in inches; this multiplied by 100 gives the diameter of the covered wire in mils. Call this d_1. If the length of the core, or the space allowed for one magnet coil, be represented by e in inches, and the number of magnets on the machine by n, then it is evident that the number of turns per layer for one magnet will be

$$\frac{1{,}000\, e}{d_1}$$

while the number of layers will be

$$\frac{1{,}000\, c}{d_1}$$

and the number of turns per magnet $\frac{W}{n}$ will be their product,

$$\frac{W}{n} = 1{,}000{,}000\, \frac{e\, c}{d_1^2}$$

thus enabling one to calculate W directly, and consequently to determine a from $(a\,W)$

$$a = \frac{(a\,W)}{W}$$

If this current, a, is found to be very small, it might be more advantageous to use a greater current and less turns, and therefore less thickness, in that way decreasing the cost of the magnet wire, it being no small portion of the cost of the material of the machine.

If for a large machine the current turns out to be much smaller than 1·5 to 2·5 per cent. of the whole current, it shows that the machine has not the most economical proportions, and that the same frame may

be used, in case of incandescent light machines, with an armature having thicker wire and less turns, and therefore capable of supplying more lamps. Or in case of arc light machines, the same frame and armature may be used to give a higher potential at the same speed, thus supplying more lamps.

After finding what a is, it is advisable to calculate what current per square mil. this will give with the determined diameter, d, in order to guard against heating. In large magnets it should not be more than ·0013 ampères per square mil. If it is found to give a greater value than this it is safest either to take a smaller current and more turns, or to increase the diameter slightly. In many cases it will be found that the diameter obtained from the formula—in which it depends on the allowable resistance—will be larger than that which would be obtained if it were calculated not to heat too much; but it is always safest to calculate both and take the largest.

If the current is found to be a large proportion of the total current, or if for the circulated diameter it is found that it will heat much, then the machine is overworked and ought to be used for doing less work, either by using the same armature and requiring the machine to give less electromotive force, or it may give the same electromotive force and less current, by taking a different armature with more turns of wire in it.

Owing to the fact that in most cases some insulating material, such as card-board or thick paper, is placed between some of the layers to ensure an evenness in the winding, the real thickness of the coil will be thicker than that assumed in the calculation, and, therefore, the mean length and resistance will be slightly different, but this error is covered by the factor of safety of 20 per cent. in the allowable resistance.

For the sake of appearances the last or outside layer is always wound full, thus limiting the number of windings to certain successive numbers which are multiples of the windings in one layer. In general, however, if the number of turns be increased a little, the resistance will thereby increase, and, therefore, the current decrease, but the product of the current into the number of turns will remain approximately the same.

If after the magnets are finally wound and the finished machine tested, it is found that owing to some slight error it gives a slightly lower or higher potential, the speed may be varied slightly to make up for this.

Having made all the calculations for the magnets of the finished machine, it is best to check them finally by calculating the resistance from the following formula:

$$R = 50{\cdot}13 \frac{W\, l_m\, \theta}{d^2},$$

or if as before θ is taken 0·0162, and the temperature is assumed to be 70° F.

$$R = {\cdot}875 \frac{W\, l_m}{d^2} = \frac{3{\cdot}5\, W\, l_m}{4\, d^2},$$

in which d is in mils, and l_m is the corrected mean length in inches, of a winding.

From Ohm's law

$$R_1 = \frac{V}{a},$$

in which R_1 is the total resistance of the shunt circuit, including the adjustable resistance. The amount which this adjustable resistance may be, is evidently

$$R_1 - R.$$

If this turns out to be a negative quantity, that is, if R is greater than R_1, there has evidently been a mistake made in some of the previous calculations.

If the calculated value of R is found to be too great, owing to the fact that the gauge number of wire taken was a little smaller than the value given by the formula, then it is quite safe to take the next size larger and keep about the same ampère windings, or else to modify the ampère windings accordingly, and then calculate R again as a check. It is quite safe to take a slightly larger diameter of wire for the same number of windings without any fear of increasing the resistance, for, from the formula of R, it will be seen that it increases only slightly, with an increased value for l_m, but decreases much more rapidly for a larger value of d.

If it is desired to regulate the machine for supplying the same potential to less lamps, by adjusting the resistance included in the shunt circuit, it is evident that it is only necessary to increase this resistance the proper amount, which can be done after the machine is finished, as it will change nothing in the preceding calculations.

If the machine is for arc lights in series, and it is desired to regulate it to supply less lamps, it will be necessary to make the test for both the maximum and minimum number of lamps and then make the resistance of the wire so low that in either case it is not too high to take its proper current, as required by its ampère windings for that particular potential.

The total length of the wire, in feet, for all the magnets will be

$$L = \frac{W\, l_m}{12} = {\cdot}0833\, W\, l_m$$

To illustrate the calculation of shunt magnets by the above-described method, let us assume that a certain machine with a given cylindrical armature and a frame with four cast-iron oval magnets, was required to supply 100 lamps of ·7 ampères each, that is, 70 ampères, of 100 volts. The speed is to be 1,200 revolutions.

Upon running the machine with four temporary magnet coils of 250 turns each, it was found to require an exciting current of 40 ampères to make the armature deliver 70 + 2·5 per cent. of 70 = about 72 ampères at 100 volts. This gives 250 × 4 × 40 = 40,000 (a W), as a measure of the magnetism.

The dimensions of the oval cross section were 9 inches by 3 inches. In order to determine the mean length of a winding, assume temporarily a maximum thickness of coil, one-third of 3, or 1 inch. The periphery of the core was measured and found to be 20 inches. This gives a mean length of one winding:

$$l_m = l + \frac{2\, c\, l}{a + b} = 23{\cdot}3 \text{ inches};$$

therefore from the formula

$$d = \sqrt{{\cdot}875 \frac{(a\, W)\, l_m}{V}}$$

assuming a factor of safety of 20 per cent. that is taking V equal to 80 volts instead of 100, the value of d is

$$d = 102 \text{ mils},$$

which is approximately equal to No. 10 wire.

Suppose this has an outside diameter of 125 mils. From the formula given above, the length of the core being 10 inches, there will be 80 windings per layer on each magnet, and 8 layers and therefore, 640 × 4 = 2,560 windings in all. This gives $\frac{40000}{2560} = 15{\cdot}6$ ampères in the windings. This very large current, which is 22 per cent., of the current in the external circuit, shows that the machine is very much overrated, and that it would not be economical, and even hardly possible, to finish the machine for 100 lamps. The heating would also be too much, for 15·6 ampères in a No. 10 wire is ·0019 ampères per square mil, which is too great. Furthermore, the core is more than saturated, for its area of cross section is about 21 square inches, which gives for 10,000 (a W) per magnet, 475 (a W) per square inch, which as compared with the constant 240 is far too great. Suppose the curve of magnetisation was found by the test to be $a\, d$ in Fig. 1. [*See* p. 228, March 12th.] It will be seen from it, that at 40,000 a W the magnets are very much oversaturated. This curve would have been sufficient in practice, without the above calculation to show that the machine was overrated, but for the sake of illustration here, the calculations were also made.

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From these figures, and from what was said above, it will be seen that the magnets would have to be altered in order to use the machine with this armature. As they are over saturated, they will have to be given a larger cross-section. For a proper percentage of current for the magnets, the large number of windings would make the thickness c of the coil much larger than it ought to be, from which it follows that the new magnets must also be made longer. In other words, these magnets have shown themselves to be much too small for that armature, or the armature has too few windings for the magnets.

The same machine was then run with another armature, which had more turns of thinner wire, the size of the wire being such as to stand a current for 70 lamps. Another armature might have been made with the same thickness of wire, but with more layers, thus supplying about the same number of lamps; but this increases the per centage of loss of energy in the armature, it increases the lead of the brushes, increases the self induction and the sparking, &c., and is, therefore, not advisable.

Suppose the test with the new armature gave 18,000 (a W). Then the following values would be obtained directly from the formulæ:

$$d = 67{\cdot}8 \text{ mils.} = \text{about No. 14.}$$
$$(d_1 = \text{about 88 mils.})$$
$$\text{W} = 110 \times 11 \times 4 = 4{,}840$$
$$a = 3{\cdot}7 \text{ ampères.}$$

The density of current in the wire should be ·00115 ampères per square mil., and therefore, as compared with our constant ·0013, it is safe against heating too much. The density of magnetism in the cores would be 214 ampère windings per square inch, and therefore, inside of the limit. The curve of magnetism, which will naturally be the same as before (except that it has a different scale for the abscissæ or volts, which does not affect the saturation), shows that for 18,000 (a W) the magnets are not quite saturated.

The resistance will be

$$\text{R} = {\cdot}875 \frac{\text{W}\, l_m}{d^2} = 24 \text{ ohms,}$$

giving an adjustable resistance of

$$\frac{\text{V}}{a} - \text{R} = 27 - 24 = 3 \text{ ohms.}$$

The reason why this is so small is because the resistance of the coil is greater, being 24 ohms, which is due to the fact that we selected the smaller size wire, No. 14, which is 64·08 mils. diameter, as that is the nearest to the calculated value of d, 67·8. If we take the next size larger to 67·8 mils., that is, No. 13, the resistance would be much less, but at the same time the current, a, would be greater, as there would then be less turns for the same allowable thickness of coil.

If this adjustable resistance of 3 ohms is thought to be too small to admit of the proper regulation or adjustment, the speed may be increased a little, or the next size larger wire, No. 13, might be taken.

As the density of magnetism in the core is shown to be 214 (a W) per square inch, it will be seen that in a second machine of the same type the cross-section of the magnet cores may be decreased, thereby diminishing l_m, which decreases d; which in turn increases R and decreases a; thus diminishing the cost of the wire and the cost of the energy to supply the magnets.

The cross section of the magnets may be decreased to such an extent as to bring the density of magnetism up to the saturation point, as given by the curve.

The constant 214 also shows that the same machine may be run at a less speed, or it may be used to give a higher potential, or the same frame may be used with an armature having a few turns less and slightly thicker wire, thus supplying more lamps.

As the density of the current in the wire is below ·0013, the first cost of the machine may be diminished at the expense of the efficiency, by taking more current in the magnets and less windings, and therefore less wire.

By a similar course of reasoning, it will often be found, from the results of such a test and the deductions made from it, that certain improvements can be advantageously made in the machine.

NEW TELEPHONE TRANSMITTERS AND RECEIVERS.

OUR second illustration shows a vertical section of a transmitter patented by Messrs. Edison and Sigmund Bergmann, which consists of two parts between which the diaphragm is held. The latter is clamped with packing rings, by which it is insulated from the case and by which a closed chamber is formed at the back of the diaphragm. The chamber is filled with liquid through the tube shown, which is closed so as to seal the instrument, preventing escape or evaporation. While a liquid is employed in this transmitter, it must not be inferred that it comes into the category of what are known as "liquid transmitters," as the liquid here only plays a mechanical part in the construction. In the new transmitter the liquid limits the movements of the diaphragm, which in turn limits and controls the separation of the electrodes. The liquid body, by preventing an excessive movement of the diaphragm, prevents the electrodes from moving too far, so that they quickly return to their normal position, and all the sound vibrations are responded to from the normal position of the electrodes. The liquid is preferably of oil, but may be of any other nature—mercury, for instance. The contact points are located outside of the liquid, as represented. A platinum contact point is carried by the front of the diaphragm, and against it bears another contact point, of platinum, carried by a screw. This screw is supported rigidly in the bridge within the front of the case, and is adjusted by a spindle. To close up the telephone and prevent the saliva from reaching the contact points, a second diaphragm is employed, held in its place by the mouth piece.

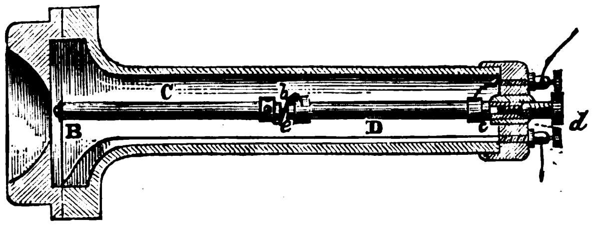

FIG. 1.

The telephone receiver is the device of Mr. Bergmann, of New York, and consists in the employment of one or more magnets acting upon a diaphragm so arranged and connected that the current passes axially through them, an adjusting device being provided to vary or regulate the extent of the space through which the force is exerted. Mr. Bergmann has found that when this is done the vibrations of the diaphragm correspond with the variations in the axial current, and sound is produced in accordance with the vibrations at the transmittter, the action being due to variations in magnetic intensity.

The best results have been obtained by arranging two or more magnets in line, with their ends in close proximity, such ends being connected by suitable conductors of the current. The magnets are connected in circuit, the current passing through them from end to end, or from centre to ends, or ends to centre in both directions.

Fig. 1 shows the receiver, which has been designed with special regard to simplicity of construction and to permanence of adjustment.

As will be seen, C, D, are two magnetised steel bars. These bars are arranged in line, with their adjoining ends in close proximity, leaving a space, b, for mecha-

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nical movement between them. One bar is attached to the diaphragm and the other is supported by a sleeve, *c*, which is adjusted from the end of the case by a screw, *d*, so as to increase or decrease the attractive space, *b*. The adjoining ends of the magnet bars, C, D, are connected by a conductor, *e*, suitably arranged to permit free movement longitudinally of the bars. The terminals (or circuit connections) are connected one with the outer end of bar, D, through the adjusting sleeve, *c*, and the other with the outer end of

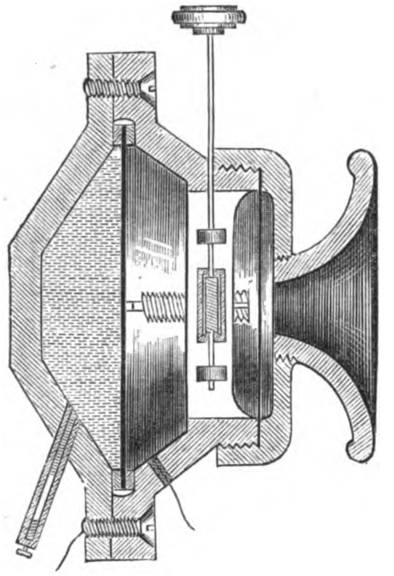


FIG. 2.

bar, C, through the diaphragm. The current of the circuit flows from a terminal through magnet bar, D, conductor, *e*, magnet bar, C, and diaphragm to the other terminal, or in the reverse direction. The effect is to vibrate the diaphragm and translate the telephone current vibrations into articulate speech. The effect is modified by adjusting the screw, *d*, and varying space, *b*.

It has been found that where two or more magnets are used the best effect is obtained if the opposite poles of the magnets are brought together, although the instrument operates when the same polarities are in proximity. Among the various modifications of the instrument is one in which electro-magnets are employed.

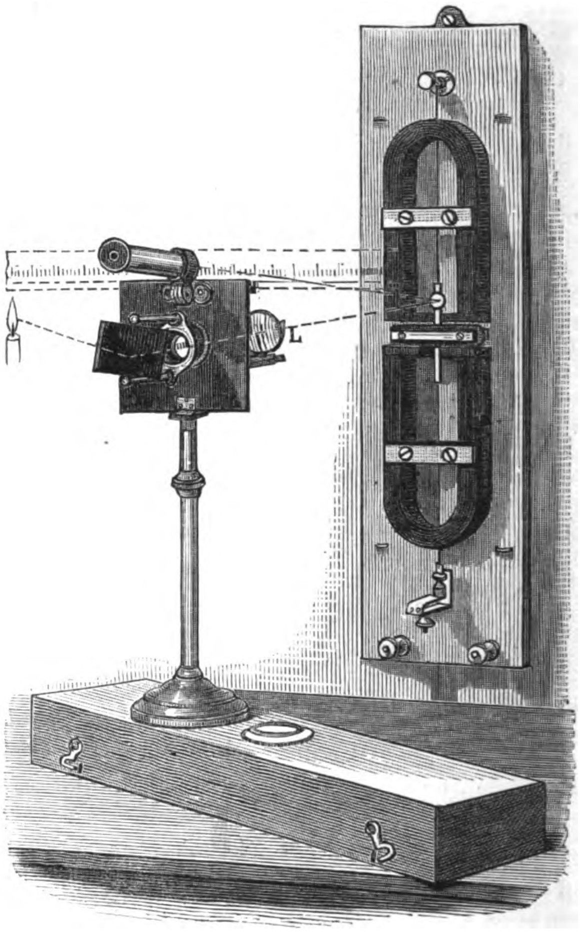
IMPROVEMENTS IN GALVANOMETERS.

M. E. DIEUDONNE describes, in *La Lumière Electrique*, certain improvements in galvanometers devised by Dr. d'Arsonval. The primary object of the inventor is the study of animal heat, but the modifications which he has introduced are likely to be of general utility. He has invented a micrometric scale which renders it possible to increase the sensitiveness of a mirror-galvanometer to any extent. He has recourse to an optical method, which bears entirely upon the process of reading off without increasing the inertia of the apparatus.

The process of Poggendorff generally employed consists in fixing a plane mirror to the movable portion of the galvanometer, and examining the image of the graduated scale through a telescope. He obtains thus an image smaller than the scale which is then magnified by the eye-piece of the telescope.

The sensitiveness is not proportional to the distance, since the image becomes smaller and smaller the further it is removed.

Dr. d'Arsonval, whose arrangement is shown in the accompanying figure, uses a scale in twentieths of a millimetre, photographed on glass, and illuminated by means of a lens or a mirror. A lens gives a magnified image, which after reflection in a second mirror is still further magnified by means of a second mirror furnished with a wire grating. The inventor substitutes for the plane mirror, not easily obtained, a concave mirror silvered on its posterior surface. He takes a plano-convex lens, silvered on its hinder surface, which thus forms a concave mirror giving a perfect image which can bear magnifying to 100 diameters; the sensitiveness of the apparatus is increased in the proportion of the magnifying power. Hence it is possible to read the slightest deviations with great precision, which renders the galvanometer both proportional and ready to use.



By a very simple arrangement this apparatus is transformed into a Carpentier's transparent scale. To this end a wire extended vertically is substituted for the micrometric scale, and for the eye-piece a graduated scale of celluloid, as is represented in the figure. The lens, L, placed in front of the micrometric scale answers a double purpose ; it increases the clearness of the image, and, as it is movable, we may by simply sliding it, alter the magnifying power of the apparatus.

The arrangement being placed at 1·20 metre from the galvanometer, we can distinguish a displacement of the image equal to $\frac{1}{40}$ millimetre, or an angular deviation of $\frac{1}{400}$ of a degree of a circle.

THE HUMAN BODY AS A CONDUCTOR AND AS AN ELECTROLYTE.

DR. W. H. STONE delivered the first of three Lumleian lectures on this subject at the Royal College of Physicians on Thursday, the 8th inst. He commenced by thanking the president and fellows of the venerable society in whose library they were assembled, for the permission they had granted him to issue more than the usual number of invitations to scientific friends who were not immediately connected with the medical profession, but

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many of whom had materially helped him in his investigations, which had now lasted for five years. Amongst those to whom he was especially indebted and whom he wished sincerely to thank were Mr. Gregory, Dr. Oliver Lodge, Mr. Lant Carpenter, and, not least, Prof. Hughes. He then proceeded:

Let me begin by saying what these lectures are not going to be: they are not going to be lectures on what is called medical electricity, which is a term of ill-omen and is, indeed, incorrect. Hitherto the application of electricity to the human body has certainly not come up to expectations: it is evidently in embryo, in a state of origin, and it has come into use in medicine in a somewhat oblique and accidental manner. It is a good physiological stimulant, a good test of muscular irritability, and in this way it has been taken up more in a physiological than in a physical light. Besides this it has suffered grievously from misrepresentation. We see every day in the papers that "Electricity is life!" Now this is most undoubtedly untrue. No doubt some day we shall be able to find out a closer relationship between electricity and life, but we are not at present justified in making such a statement. What I am going to endeavour to do in the three brief hours allotted to me is to establish certain physical conditions with regard to the human body and to apply them in a more natural fashion than has been done by previous investigators, more from the inorganic, more from the physical than from the physiological side.

Very early in the history of electricity the physiologist seized upon it, and very properly; distinguished men seized upon it and used it as a means of causing irritation in nerve and muscle. Having referred to the experiments with the galvanoscopic frog, Dr. Stone said that was too delicate a test, was an unmeasurable test. The induction coil is a very complicated electrical apparatus, the actual working of which has hardly been fathomed by physicists. We have lately been able to find an apparatus which would, to a certain extent, supplant the galvanoscopic frog, an equally delicate instrument, and we are beginning to get at the action of the induction coil. Now, I will only say how we can replace the galvanoscopic frog by the newly-invented telephone, and so find out more than we previously could regarding the currents that pass through the induction coils. I have here a Du Bois-Reymond coil, and I have laid on an electrical wire along the room to a series of telephones, and when I put the battery on I shall be able to make the telephones respond, jar and jerk, as does the galvanoscopic frog. Having shown the experiment, Dr. Stone continued: I shall refer to it in the third lecture, but I wish to show you that the telephone can be used with induced currents as a galvanoscopic frog. The first discoverer of this fact was Prof. Hughes.

I propose to occupy myself, in the short time at my disposal, with the resistance of the human body. There were a great many early discoverers that the human body places some obstacles in the course of an electrical current, and the technical term for this condition is resistance. Volta himself worked at it, and a number of observations have been made by distinguished men. But the first serious attempt to obtain the real resistance of the human body was by Edouard Weber and by Wilhelm Weber, of Gottingen. I have an account of that in a work by Du Bois-Reymond, but time does not allow of my quoting it. The best work among the early writers upon the subject is undoubtedly that of Du Bois-Reymond. All those early investigations turned out unsatisfactorily. Even Du Bois-Reymond himself could not account for it, and he has written somewhat to the effect that he has given it up in despair. In this very treatise of which I have spoken, he says: "In no part of this province do we meet with such unaccountable freaks of experiment. The proving of the most insignificant fact often calls forth efforts out of all proportion, and whilst in other cases the discovered contrivances lasted for long hours of experiment, we are now in the position that a single experiment demands preparations which, if not complicated, will necessitate detailed preparations; whereby these experiments are the most lengthy one can imagine."

Among the early investigators in this direction were Volta, Humboldt, Lenz, Gilbert (1801), Ptschelnikoff, Fechner (1839), Edouard Weber and Wilhelm Weber (1835), Comte du Moncel; but their careful experiments are deprived of value by the fact that the polarisation of the electrodes was not taken into consideration. There is another reason why these early observers failed entirely. That is, that Weber and those who followed him took the view that it was a matter of indifference whether you measured the resistance of the human body with an ordinary low tension current from a battery, or with the high tension, secondary, induced or momentary current from an induction coil. I believe I may claim for myself the small merit, if merit it be, of having found that the resistance of the human body with the ordinary battery current and with the induced current is totally and entirely different; I shall be able to show you it is very often only half and seldom more than two-thirds what it is with the ordinary battery current. For this reason I fear the observations of Weber and others must be discarded as untrustworthy; they cannot be taken as they stand.

There is a very good paper by Du Moncel in which is what I may call the first approximation to a real estimate of the conductivity, or the resistance, of the human body. It is in a wonderful paper of his on the conduction of moderately good conductors, of imperfect conductors, and he says at the end: "The conductibility of the human body, although acting very much like those we have spoken of, presents certain peculiarities." He then describes his experiment: "During the experiment I employed electrodes of platinum, which I tied pretty strongly on the internal wrist of the patient." He gives a description of the experiment, which lasted an hour and a half. The only misfortune was that, without intending any harm, he decomposed his patient—who was in this case his wife—he electrolised her. Du Moncel is gone to his rest, but the old lady is still alive and bears the traces on her wrist of the tremendous ulceration which he caused. Although he produced a great error by this electrolisation, he got an estimate which is an approximation of the real resistance of the human body. He said it was about equal to 350—and sunk to 250—kilometres of telegraph line. In those days there was a unit used in Switzerland and France, which was called the French unit, and was equal to a kilometre of iron telegraph wire. This kilometre of iron telegraph wire, four millimetres in diameter, may be taken practically as 10 ohms; therefore his estimate was from 3,500 to 2,200 ohms, a very wide margin, but the latter of the two is an approximation of what it really is. It is astonishing that he did not get a lower resistance seeing that he destroyed the epidermis and caused ulceration.

Now, what is the reason that these difficulties have existed? The moment I began to experiment I saw there were two, if not three. The first is the difficulty of making good contact, and up to lately there never has been proper contact made. The electrodes used by Du Moncel were only 4½ centimetres by 3 centimetres each—that is, an inch and three-quarters, English measure, by an inch and three-eighths—and the proof that they were not large enough is that the density of the current was so great as to cause physical injury. Then the difficulty, first of all, is to make good contact. The human body is somewhat like a condenser or a cable; it is a mass of conducting material contained in a highly insulating envelope; indeed, so good an insulator is the skin that it is quite possible to excite a frictional electric machine by the dry palms of the hands.

Then, secondly, comes the fact that the human body rapidly electrolises. The human body, I shall be able to show you in a second lecture, is a secondary battery of no inconsiderable power, and when even a small

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current is passed through it, electrolytic decomposition is set up which can be reproduced in an antagonistic current, and which, of course, modifies entirely the measure of resistance.

Besides that there is a third action. That I name in the syllabus the electro-chemical capacity. In the paper I read before the British Association at Southport I spoke of the human body as a condenser. So rapid is the progress of science that I must now modify that term. I think Prof. Hughes's brilliant researches, which have only been public within the last two months, give me a far better name for that third condition of the body which has given me so much trouble, and I shall now call it "self-induction." That, again, I must leave until a later lecture.

As to contact and the mode of investigation, it is obvious that any contact resistance from the skin must as far as possible be eliminated. We do not want to know the resistance of the skin; that can go up to any amount; it is given by the latest writer on electro-therapeutics, Dr. Rosenthal, as from 8,000 to 20,000 ohms. What we want to know is the resistance of the tissues which underlie this insulating layer. The physiological conductivity of the deeper tissues, not of the mere skin, is what we want to measure, and the fair statement is that the contact should be infinitely large, mathematically considered, compared with any current which can be sent through it. If this condition is complied with, the resistance can be brought down to something very moderate indeed. I employ, therefore—and I find I am anticipated in this, as in many other things, by Du Bois-Reymond, who lighted upon it more by accident in the beginning—simply salt and water. I tried mainly saline solutions, but thinking of lead as being a very inert body in the electrical scale, I tried two large leaden poles; and these have answered. If the patient is confined to bed I place a little salt water solution on his feet or hands, and so I get a good contact. When I have my contacts, it is important, in the next place, if I am to measure the resistance, that I should take anatomical points, so as to make sure that the same proportion of the patient is traversed by the current in every case, and I have found two very convenient indeed. One is this prominence at the wrist, the ulna, which is marked in most people, and the other is the external prominence at the ankle. The advantage is that when the patient is stripped you can take a tape and get the measurement of the human conductor certainly within a quarter of an inch. Therefore, these are the two points I generally use.

For measuring I have used in some instances Wheatstone's bridge. Any battery which is easily managed, and has a tolerably good E.M.F., will do; I now use chromic acid pure, which works better than bichromate of potash, and these cells, in good working order, may be said to have an E.M.F. of two volts each; therefore, so many batteries varies the number of volts. Their internal resistance is so very small, even compared with the internal resistance of the human body, that you may neglect it. Then, having your contact—I may say I tried a number of other methods of securing contact, but they were all more or less unsatisfactory, wet carbon, spongy fibre, and I was also allowed by some students to introduce a surgical instrument and so get through the epidermis; but this hurts very much, and very few would stand it, so I came back to the leaden contacts. Besides that, I have to say, in what directions do we want to pass the current? There are four directions in which it is worth while to pass the current: from hand to hand is commonly used, but from foot to foot involves a greater amount of tissue, so that is the most interesting to us; but from hand to foot is of very great value. You must pass it through limited parts of the body, and from foot to foot, and from hand to hand, and then from foot to hand on either side will give you a very good estimate of the resistance through the main tissues of the body.

As regards length, it is in the legs that a tall man differs most from a short man. I have had the opportunity of measuring some of very greatly varying heights, and the results with some of the most remarkable I have tabulated on the board.

	Height.		V to M.		R.	
					Foot to Foot	Foot to Hand.
	ft.	in.	ft.	in.	ω	ω
Mr. Todd	5	6	5	9¾	945	1320
Mr. Shackell ...	6	3	7	0	930	1027
Hungarian Giant ...	7	6	8	7	930	1032

With regard to the method of momentary contacts, I have in circuit a Wheatstone's bridge of a rather particular form, a commutating key so as to send the current in opposite directions, and I have a double contact key as it is called, by which I can make contact through the battery, and afterwards through the galvanometer. In this way I think I shall lessen the effects of polarisation; the observations given were taken in this way, and they agree remarkably well.

An experiment upon a porter from St. Thomas's Hospital, an athletic young man, was then conducted, the measurement being taken from foot to foot, with the result that his body showed a resistance of 1060 ohms. Dr. Stone proceeded:

The reason why I use these alternating currents is because of the second difficulty, the difficulty of polarisation. Polarisation causes the resistance to rise steadily. I believe I could possibly demonstrate that if I put on this current for some little time. This polarisation is really chemical decomposition taking place inside the body, and it acts as an opposing E.M.F. For a long time I was very much troubled in this way. I could not get any readings that would agree with one another. Indeed, Du Bois-Reymond seems to have been troubled in the same way, for he ends without giving the resistance of the human body. He says, "I have not taken the trouble to ascertain the resistance of the human body," by which I really think he means he could not get any congruous readings.

So far had I reached when my friend Dr. Oliver Lodge suggested to me, "Why not use Kohlrausch's principle of the induced current, and use the telephone for a galvanometer?" This method is extremely pretty and charming, and upon it I wasted a year of work.

There is another wonderful thing, the cross results we obtained differ as much as from 1 to 2 or 1 to ½. I propose to take that very diffcult subject later, and I am now going on to speak of other methods which were suggested to me. Momentary contacts I have mentioned; alternating currents I will leave till the third lecture; I have still to speak of the second method—that of Mr. Mance, which has, I hope, solved the difficulty for me without the use of alternating currents. Sir Henry Mance, as he now is, is superintendent of the Persian telegraph system, and on May 8th, 1884, he brought before the Society of Telegraph Engineers and Electricians a method of eliminating the effects of polarisation and earth currents from fault tests. It is a very technical thing, but it amounts to this, that the cable which is leaking is liable to set up a counter E.M.F. similar to that I have named, and which I shall presently demonstrate as occurring in the human body. The body very much resembles a faulty submarine cable, and it occurred to me that this method might succeed better than the one I had wasted so much time on. I found it answer extremely well. I had some correspondence with Sir Henry Mance, who said that he made a few experiments touching the resistance of the human body, but had no leisure to continue them. From hand to hand he found the resistance from 900 to 1,100 ohms; the observed resistance was higher in consequence of polarisation, but he always corrected the results of his formulæ. He did no more than test one or two individuals. These determinations of Sir Henry Mance's were the first that could be called absolutely correct.

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His method amounts to this, that instead of cutting the current as short as possible to stop polarisation, you let polarisation do its worst. and then you alter the conditions of the problem by shunting what are called the proportional coils; you change the resistance of the whole circuit, take an observation under totally different conditions, and then by cross-equating you are able to remove what is disadvantageous, leaving behind only what is really good, true gain. Mance's method was used originally on the Persian Gulf cable, and is as follows:—

Let $P_1 = R$ of coil A; $P_2 = R$ of coil B; $R_1 = R$ with coil P_1; $R_2 = R$ with coil P_2;

then
$$x = \frac{(R_1 \cdot P_2) - (R_2 \cdot P_1)}{P_2 + R_2 - P_1 - R_1},$$
or
$$x = \frac{A - B}{C}.$$

I will endeavour to take a test on this method. Here I have two proportional coils which are united by a cross-piece, so that I can switch them on at one motion. Dr. Stone then carried out the experiment on the hospital porter, getting a resistance in the first place of 1,070 ohms, rising afterwards about 10 ohms in consequence of polarisation. In a previous experiment with the same patient, he stated, the resistance rose 7 ohms. Continuing, he said:

There is a very good diagram there, made independently from me, in which the volts are shown on one side, the current in ampères on the other; the E.M.F. was steadily increased so as to show the effect of it. The first two observations were made by Mr. Lant Carpenter and Mr. Wilkinson, independently of me. The third was made by me on the same patient some time before, and the agreement is really most satisfactory. The resistance from foot to foot began at 1,194 ohms,

E.M.F. volts.		Resistance, ohms.	Current, ampères.
2	1st minute 4th "	R = 1194 R = 1230	·0016
4	4th "	R = 1155	·0034
8	1st " 4th "	R = 1130 R = 1160	·0069

and went up after four minutes to 1,230. Four cells were put on, and seemed to break down the resistance, which was then 1,155 ohms. These observations were made by taking the deflections of a galvanometer. Eight volts were put on, and the resistance was 1,130 ohms, rising after four minutes to 1,160.

There comes out of this, putting aside the fact that the resistance of the body is infinitely less than has been thought, a question which has often been asked me, does the size not make a very great difference? If the patient be healthy, well-nourished, and the muscles in good condition, it does not. I can trace here a very distinct mechanical law, that as is the length of the levers so will be the cross-section, the bulk, or the diameter, of the muscles that move them. So it appears in these three men of very different statures, every one of them active, vigorous men, and oddly enough the smallest man gives the highest resistance by a little, but from foot to foot there is only 945 against 930. The Hungarian giant, a splendid man, well-trained, gave exactly the same figure as Mr. Shackell, who, I believe, at football and other games, was equally active. A difference is shown from foot to hand: you have to pass through a very narrow conductor in the arm, and so the big man comes out a little more, but only 5 ohms. This establishes a physiological fact, which is extremely important. I do not claim this as universal; in diseased tissues, and in extremely fatty bodies, of course considerable differences take place. In ordinary health, however, you may say that the height does not materially modify the resistance.

To draw to my conclusions, we must not calculate, as lately we have been doing a great deal too much, upon the safety of currents merely on the insulating power of the epidermis, which may be accidentally broken down by so trifling a matter as the saturation of the epidermis with salt and water. Many sad accidents are undoubtedly due to the fact that for a moment the insulating power of the skin is broken down and a strong current passes.

Mr. Cunynghame finds the resistance 2000 ohms between hand and hand immersed in acidulated water. He has written me a letter in which he says: "May I suggest that there is one aspect of the question which I hope you will see your way to treat, that is, the real limits of safety for dynamos as to E.M.F. and intermittency, as the subject has never been adequately treated, and the Board of Trade is much at sea on the question, particularly with regard to the limits of safety." They at present put down 200 volts as the outside limit to be allowed, but dynamos now running go up to 800 volts. No doubt, as time goes on, there will be more unfortunate men who will put their hands on the two brushes of the dynamo and will meet with sudden death. At present accidents occur more serious than we know of, for I am afraid there is a trade coalition to keep them concealed. I think this, we, as physicians, ought to stand out against. It is thought that it will injure the future of the electric light commercially if these accidents are known, so they are explained away or hushed up by compensation or a present. This, I believe, is a false system altogether.

Now we come to the consideration of whether these observations may be made useful in the treatment of diseases, and I will give a sketch of how the facts ascertained may be utilised, to show you that this enquiry is not unpractical. It has given me great trouble to discover—and I cannot say that I have settled the point to my own satisfaction—whether the human body acts as a fluid conductor or as a solid. Du Moncel and Du Bois-Reymond take it for granted that it is fluid by virtue of the water it contains. I am doubtful of this; indeed, certain observations I have made seem to point the other way. I have also found that the occurrence of dropsy, when the tissues are water-logged, enormously reduces the resistance. The resistance in a dropsical patient sunk to one-half and remained there. Then I find that degenerated tissue, and tissues where muscular fibre has been replaced by common fibrous tissue, have become infinitely less resistant. Muscle would, therefore, seem to be not so good a conductor. Then, I had six cases of hemiplegy, and in all these cases the hemiphlegic side resisted less than the fibrous tissue or healthy side, being, therefore, a better conductor than the side on which the muscle was sound. In one case the resistance was 420, in others 350, 360, 120, 550, 730 ohms, all in the same direction, and this surely can not be all wrong. There will be some evidence of its being an instrumental error, but I think I may take it that paralysed muscle conducts even better than healthy muscle.

I think we may say that certain metallic impregnations do influence the conductivity of the body. I have had a large number of cases of mercury, lead and copper impregnations, and have been working, hitherto unsuccessfully, with silver. The lead was not very marked in its effects, but mercury produced a considerable difference, and in one case of copper impregnation I found that the right hand, with which the coppersmith used his hammer, conducted much better than the left, which he did not use so much in his trade. In this case I was able to complete the observations, and by examining the urine proved that he was impregnated with copper; I extracted three milligrammes of copper.

The point of temperature I am hardly prepared to speak with certainty upon, but I have recorded the actual figures in a very curious case, and I found that when the body was hot the resistance, instead of being less, was greater.

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THE STRANGE HISTORY OF A DYNAMO,

As told by itself to

A. DYNAMICABLE.

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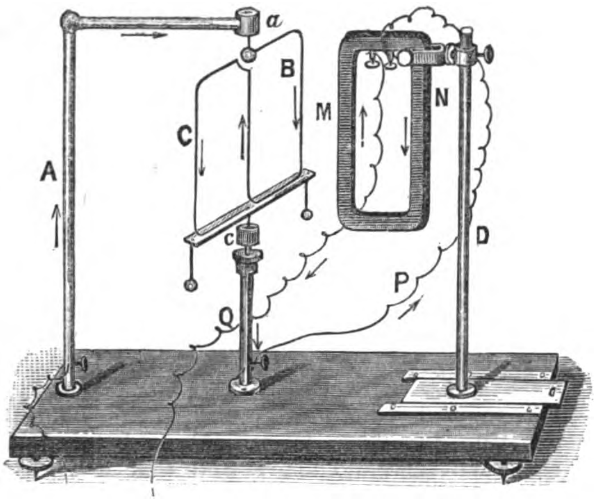
(*Continued from page* 328.)

I HAD almost forgotten to tell you, for I am but little used to talking of myself (except to myself), that this happened, to the best of my remembrance, in the month of July, 1820. This germ, from which I was gradually developed, was not allowed to remain in a chrysalis state, for a few months later on a French scientist of great eminence, Ampère by name, found that it possessed greater vitality than Œrsted gave it credit for. The Frenchman, going further, discovered not only that a galvanic current moved a magnetised needle placed within the range of its magical influence, but also that two currents would reciprocally act one upon the other. You will naturally infer from this that one of the wires or circuits which the currents traverse must be arranged in such a manner that it is free to move, and I cannot call to mind a better way of making this clear to the public than by briefly describing the modified and improved form of Ampère's apparatus, a sketch of which I will now trace for you.



AMPERE'S APPARATUS.

It consists of two brass columns, A and D, having between them a shorter one. On the frame, M, N, is a coil of wire and this can be adjusted to any height and position by means of the sliding clamp. The short column is hollow and carries a brass tube terminating in a mercury cup, *c*. On column A is another similar cup, *a*, having in the bottom a tiny aperture through which passes the point of a sewing needle fixed to a little copper ball. The movable part of the circuit is a wire shown by the arrows and extending from *a* to *c*. Now a strong galvanic current ascending by column A to the cup, *a*, traverses the movable circuit or wire, B, C, reaches the cup, *c*, goes down the central column, through the wire, P, to the coil, M, N, returning to the source of electrical energy or battery by the return wire, Q. Now, when the current passes, the wire, C, B, will be freely moved, thus showing that currents act inductively upon each other as well as upon magnetised needles.

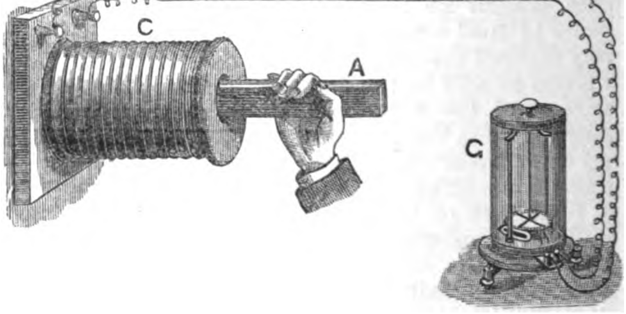
Almost simultaneously, if my memory serves me aright, Arago, a famous physicist, added yet another link to the chain of my story by observing that a galvanic current imparted magnetic properties to iron or to steel which had not previously been magnetised. You may easily verify the truth of this, for if you take a rod of iron or steel, say, four inches in length and half-an-inch in diameter, and coil round it from end to end cotton-covered or otherwise insulated copper wire, you will find that on connecting the ends of this wire with a powerful galvanic battery, the iron or steel has become highly magnetic, and that it will attract and hold with great tenacity any other piece of iron or steel which may be brought near to its ends.

Why copper wire? you say. Well, this is to a certain extent a digression from the main point at issue; but in a few words I may tell you that copper is, with the exception of silver (the price of which, of course, prohibits its use for anything but special purposes), the best conductor of electricity which we have at our command. Like water or steam passing through a pipe, electricity meets with a certain resistance in traversing a conductor, and copper offers the path of least resistance. To make my meaning more clear, a given current will pass as readily, and with as little loss, through a copper wire of one square inch in section as through an iron conductor of seven times that sectional area.

To return to myself: for the next ten years nothing was done to promote the growth of the seed then sown, so far as I am personally concerned, although in other ways the facts I have thus far related were turned to full advantage; but at the end of this period of enforced inactivity the great English philosopher, Faraday, to whom I consider you and I owe a deep debt of gratitude, which, however, *you* may not fully realise, discovered that a magnet could bring into existence an electric current; in other words that a magnet could, as well as a galvanic battery, produce a current of electricity in a closed circuit. It was through his untiring labours, pursued in such a true spirit of scientific investigation, and without that love of emolument so prevalent in our days, that the germ became possessed of definite form and wondrous vitality, whereby I am now enabled to place at the service of man that giant force with which I am endowed. Whilst upon this topic I may add that I shall have occasion to refer to another Englishman whose work on my behalf has not yet received the acknowledgment which is justly its due.

I have at times, when by myself and for the moment in a state of inactivity, pondered over the vicissitudes of my infancy and wondered how it was that Arago missed that which was so nearly within his grasp, for does it not seem strange, and in this I think you will agree with me, that the eminent Frenchman failed to see the converse of his brilliant discovery? However, English people must feel justly proud in knowing that it was reserved for their great fellow-countryman to fall upon that,—not by chance, be it known, but by that process of true philosophical reasoning which has rendered his name immortal.

Faraday's discovery is very aptly conveyed to the understanding by the following beautiful experiment. If a bar magnet, A, is pushed into a coil, C, of insulated or covered wire an electric current is generated if the circuit be closed, *i.e.*, when the ends of the coil are joined together or, as shown in the figure, when



FARADAY'S MAGNET AND COIL EXPERIMENT.

they are connected with a galvanometer, G, which forms part of the closed circuit. When the magnet enters the coil the galvanometer needle deflects, say, towards the right; if the magnet be held stationary the current vanishes, and the needle of the galvanometer returns to its normal position or zero; when the

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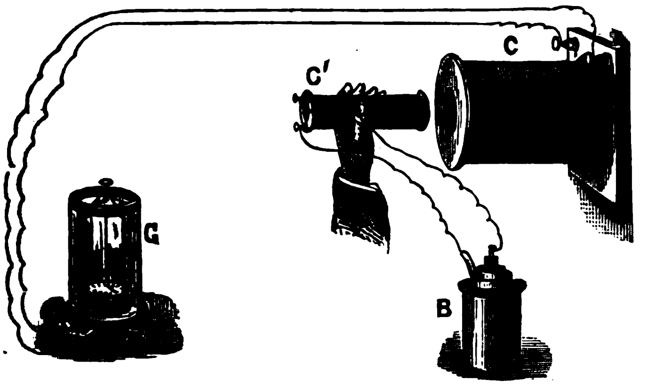
bar is withdrawn another current is generated, but in an opposite direction to that of the first; the current again has but a momentary existence, and the galvanometer needle once more returns to its rest.

From this, then, you will readily conceive that if the magnet be pushed into and withdrawn from the coil with sufficient rapidity, a practically continuous supply of electrical energy might be obtained, but from currents flowing in *opposite* directions. I wish to impress this very strongly upon your memory for reasons which will hereafter appear.

I am afraid that my story will take longer in telling than I had anticipated if you do not allow me to proceed unquestioned. What will the public understand by a galvanometer? Well, there are galvanometers and galvanometers, but it will suffice to know that it is a delicate apparatus for detecting the presence of electrical currents and the direction in which they flow, by the movements of a finely poised magnetic needle which is influenced by a coil of wire through which the currents are made to pass. Such an instrument, indeed, is figured on the extreme right of the sketch I have just limned for you to illustrate the discovery of Faraday.

I have already made it known to you that galvanic currents can act upon one another, but in order that I may be clearly understood I think it necessary that I should again refer to this point and show you yet another illustration. It will not cause you any surprise, knowing that a magnet can induce currents in a coil of wire, to learn that if instead of the magnet we employ a second coil, C_1, which will go loosely into the first, C, and through which *a current is permanently flowing* from the galvanic cell, B, similar effects will be produced in our original coil upon the insertion and withdrawal of the smaller one to those observed in the case of the magnet. I think that I have



Faraday's Double Coil Experiment.

now sufficiently made clear the discoveries which made my existence a *fait accompli*, so I will now ask your forbearance if I return for one moment to the ground we have so far covered. I do so simply to bring through your aid more prominently before the reader's notice that:—

1st. *A galvanic current passing through a coil of wire surrounding a rod of iron will make the iron, so long as the current continues, a powerful magnet.*

2nd. *That this same magnet can be utilised to produce powerful currents of electricity.*

How these facts have been developed will become apparent upon studying my progress from the time when I first felt myself able to create a ripple of astonishment throughout the scientific world to the present day.

(*To be continued.*)

Electric Bells and Speaking Tubes.—The Stockport Infirmary has been fitted up with electric call bells and speaking tubes on the system of Messrs. Durham and Co., and many architects of the town and neighbourhood have pronounced in their favour. They are also extensively laid in private residences and shops.

A VISIT TO MESSRS. CROMPTON'S WORKS.

The students of the Institution of Civil Engineers, accompanied by Mr. James Forrest, the secretary, visited Messrs. Crompton's electric light works at Chelmsford, on Wednesday, the 7th instant.

They commenced their inspection of the works in the heavy machinery department; here they had opportunities of examining the various parts of dynamos in all stages of construction.

In this department, among the numerous other large tools which were objects of considerable attention, was a circular saw used in cutting up 8 inch square bars of cold wrought iron; a large new milling machine, manufactured by Messrs. Kendall and Gent; also a large planing machine, used for all heavy dynamo bed plates.

The testing department was found to be well fitted with all the most modern appliances, including very large rheostats, measuring instruments, photometers, &c. Attention was drawn to a three-cylinder compound Willans' engine, driving direct a large Crompton dynamo; this set was of the type exhibited at the International Inventions Exhibition, and was here used for doing all electrical work required in the works for shop lighting, both by arc and incandescent lamps, and also for driving motors working the fans in the smiths' shops, and all the shafting in the pattern shop.

In the bobbin shop the visitors were enabled to examine armatures of every size and description, in various stages of completion, the sizes of these varying from an armature able to work 12 lamps at 2,000 revolutions, to one capable of generating 100,000 watts at 400 revolutions.

On this floor, also, projectors of all sizes, and hand lamps of English and other patterns, were on show. The new pattern of high-pressure steam valve, which the firm had just completed, was very favourably commented upon. In the new erecting shop was seen three complete combined plants, each capable of giving 100,000 watts at about 400 revolutions; one of these being specially put under steam for the inspection of the visitors.

Prominent among other features of interest which cannot be detailed at any length, were the fittings for a complete set of gear necessary for a lightship; these embraced dynamos, engines, boilers, glazed lanterns, containing four arc lamps, suspended on gimbals, &c.

The whole works, which employ upwards of 400 men, show in every department the steady progress which this branch of engineering is now making; and the inspection occupied the whole afternoon.

DYNAMO TESTS.

The dynamo tests given on another page show that it is possible, by combining a direct-acting engine running at a fairly high speed with a good dynamo, to obtain in the circuit between the machine terminals, a return in electrical work of over 70 per cent. of the indicated horse-power of the engine. When the installation at Victoria Station was tested, some time ago, it was shown that from belt driving an electrical return of 65 per cent. of the I.H.P. could be obtained, the friction of the belts in that case absorbing a fair share of the work wasted. Now, by direct driving the proportion of the I.H.P. appearing in the circuit has been raised to a mean value of 74 per cent., the speed of the dynamo having been at the same time reduced. This is a very good efficiency, but it appears to us that the final results as given in Table VI. call for some explanation, the figures being, to say the least of it, arranged in a rather strange way. One would naturally expect that the maximum I.H.P. would be shown when the electrical output reached a maximum, but this is not the case in the table referred to. For instance, at 5 : 55 the electrical horse-power reaches 95·65, that indicated being 118·05, whereas at 6 : 35 the

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I.H.P. increases to 130·47, and the E.H.P. falls to 89·05. In the former case the commercial return is said to be 79·2 per cent., while in the latter case it is 66·5 per cent. Some explanation of these anomalous results can doubtless be given, and it would be well if, at the same time, we have some explanation of the extraordinary and erratic variations in the efficiency in a short two hours' run. Seemingly, but little importance can be attached to the mean value of 74 per cent. when the efficiency fluctuates between such wide limits as 66·5 and 79·8, and with a knowledge of such strange behaviour as that indicated below it is difficult to determine exactly the value to place on the figures. Taking the E.H.P. appearing at the brushes we notice that between the readings taken at 5 : 30 and 5 : 35 there is in the E.H.P. a fall of nearly 10, while in the I.H.P. the fall is only 4. Again, in the next five minutes, between 5 : 35 and 5 : 40, the I.H.P. falls by 6, while the E.H.P. practically undergoes no change. The strangest phenomenon occurs at half-past six, for between the readings taken then and at 6 : 35 it seems that the I.H.P. *increases* by about 7, while the E.H.P. actually *decreases* by about 3. Finally, the I.H.P. at 7 : 25 makes a last effort and increases by 9 in the remaining five minutes, while the E.H.P. remains practically *in statu quo*. We are not necessarily questioning the accuracy of the results as to efficiency. We only wish to know why they vary so, and whether 66, 70 or 74, is to be taken as the actual efficiency for continuous long runs. It is possible that these results may be due to inefficient or intermittent engine lubrication, but we wait for explanation.

THE CROMPTON DYNAMO.

REPORT ON ECONOMY TEST OF A CROMPTON DYNAMO DRIVEN DIRECT BY A WILLANS HIGH SPEED ENGINE.

The object of the trial was :—

1. To ascertain correctly the consumption of water per I.H.P per hour of the new type of tandem compound high speed engines, recently introduced by Willans and Robinson of Thames Ditton.

2. To ascertain what percentage of the I.H.P. in the engine cylinders can be obtained as useful electrical H.P. at the terminals of the Crompton dynamo driven direct by one of these engines.

3. The above data being correctly ascertained, to show the consumption in pounds of water, and hence the pounds of coal per useful electrical H.P. per hour.

Mr. J. Macfarlane Gray, Chief Examiner of Engineers to the Board of Trade, Mr. W. H. Massey, C.E., of Twyford, Berks, and Dr. Fleming, of University College, London, were invited to conduct the trials on the date on which they were to take place. Mr. Massey, being unavoidably absent owing to illness, requested Mr. E. H. Liveing to take his place. Mr. Macfarlane Gray and Mr. Liveing took charge of the indicating apparatus, measurements of water used, and all measurements relating to the engine. Dr. Fleming took all the electrical measurements, and afterwards verified the instruments used.

Description of the Engine:—The engine tested is one of Messrs. Willans and Robinson's latest design, and make. It is non-condensing and single acting, having two high pressure and two low pressure cylinders, the high pressure cylinders being 11 inches in diameter, placed on the top of the low pressure cylinders which are 18 inches in diameter both having nine inch stroke. The arrangement of this engine was fully described and shown with diagrams during the discussion on Mr. Imray's paper on high speed engines recently read before the Institution of Civil Engineers. The engine was designed to run at a speed varying from 200 to 400 revolutions, and to develop at the higher speed 140 I.H.P., with boiler pressure of 140 lbs. per square inch. As a matter of fact it will be seen from the indicator diagrams, that the engine was rather too large for this work.

The indicating gear consisted of four Crosby indicators; the high pressure indicators had 120 lb. springs, the low pressure ones 50 lb. springs. The two low pressure indicators were also arranged to indicate the variations of the receiver pressure as the under side of the high pressure cylinder being open to the receiver, the variations of pressure in the latter affect the power of the engine.

The number of revolutions was taken from a Young's speed indicator, driven directly off the engine, checked in addition by counting the revolutions with an ordinary geared speed counter (at the end of the spindle) at the time that each set of indicator diagrams was taken.

The Crompton dynamo is of the vertical type, having wrought iron magnets 24 inches wide by seven inches thick; the armature being 36 inches long and 16½ inches in diameter. One end of the armature spindle was bolted to the crank shaft of the engine by a solid steel coupling; the other or commutator end of the spindle was carried in a spherical bearing, so formed as to be easily adjusted and kept in line with the three main bearings of the engine crank shaft. This dynamo was designed to give an electrical output of 600 volts and 120 ampères at a speed of 400 revolutions. This is equal to 72,000 watts or about 97 electrical H.P.

Means adopted to ascertain the quantity of water used by the engine.—The engine was supplied by a pair of nominal 20 H.P. locomotive boilers made by Messrs. Marshall, Sons and Company, of Gainsboro', being two of the boilers usually employed for driving Messrs. Crompton's works. The ordinary feed arrangement was disconnected, and the boilers were supplied by a pair of Hancock's inspirators drawing from an iron tank, which at the commencement of the trial was filled up to a gauge mark, and at the end of the trial was again filled up to the same mark. The whole of the water passed into this tank through a barrel mounted on an accurately adjusted scale beam, so that its actual weight was taken and no calculations were necessary. The coal used during the trial was weighed, but as the boilers were not specially cleaned for the occasion, the evaporative efficiency was not high. However, the actual results obtained are noted in the tables.

Method adopted to ascertain the electrical output.—A large rheostat or resistance coil was prepared, consisting of a continuous band of wire gauze stretched tightly over a large frame, and so arranged with switches that any desired portion could be short circuited and the resistance thus varied. The conductors from the terminals were led to this rheostat, and from thence to the measuring instruments which were placed in Messrs. Crompton's test-room. These instruments consisted of two of Messrs. Crompton's current indicators specially constructed for the occasion, and carefully calibrated by Dr. Fleming by means of a Clark's standard cell, verified against those used by Lord Rayleigh in conjunction with the low resistance, also carefully determined. The current indicators were calibrated by passing the same current through them and the low resistance coil, and measuring the difference of potential at the ends of the latter by means of the said cell.

Separate Exciting.—The Dynamo, had its field magnets excited by a separate machine. During the trials this separate machine was driven by its own Willans engine, the steam for which was supplied from a separate boiler. The E.H.P. used in exciting was subtracted from the electrical output as will be hereafter shown.

Electrical Measurements of Dynamo.

Resistance armature, hot	=	·255 ohms.
Resistance magnet coils, hot...	=	0·33 ohms.
Loss in armature at 120 ampères	=	30·6 volts.
Loss in magnet coils at 64 ampères exc. cur.	=	21·1 volts.
Watts expended in armature ... = 30·6 × 120	=	3,670
Watts expended in exciting ... = 21·1 × 64	=	1,350
Watts in external circuit, *i.e.*: Useful out-put ... ... = 600 × 120	=	72,000
Total watts	=	77,020

Percentage of total electrical power in ex. circuit, 93·5 per cent.

It was arranged that the I.H.P. should be worked out from the indicator diagrams by Mr. Macfarlane Gray and Mr. Liveing independently.

Tables I. to III. give the results worked out from 48 diagrams by the former, who employed a planimeter.

TABLE I.

Time.	Planimeter.	Difference.	Mean pressure.	Rev. ÷ 2.	I. H. P.
A. L.	1302	...	...	...	...
5.40	1321	19	7·6	172	9·28
...	1361	40	16·	...	58·65
5.45	1380	19	7·6	189	10·2
...	1420	40	16·	...	64·29
6.00	1439	19	7·6	174	9·40
...	1485	46	18·4	...	68·25
6.05	1504	19	7·6	176	9·51
...	1553	49	19·6	...	73·44
6.20	1571	18	7·2	175	8·95
...	1620	49	19·6	...	72·96
6.25	1639	19	7·6	176	9·51
...	1681	42	16·8	...	63·00
6.40	1702	21	8·4	170	10·15
...	1746	44	17·6	...	63·75
6.45	1765	19	7·6	163	8·80
...	1813	48	19·2	...	66·60
7.00	1833	20	8·0	176	10·00
...	1880	47	18·8	...	70·50
7.05	1900	20	8·0	165	9·38
...	1948	48	19·2	...	67·35
7.20	1965	17	6·8	175	8·44
...	2013	48	19·2	...	71·40
7.25	2033	20	8·0	179	10·16
...	2081	48	19·2	...	73·20

Table IV. gives the results worked out from 24 diagrams only by the latter, who used scales.

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Table II.

Time.	Planimeter.	Difference.	Mean pressure.	Rev. ÷ 2.	I. H. P.
B. L.	2081	...	...	...	...
5.30	2102	21	8·4	165	9·84
...	2151	49	19·6	...	68·9
5.35	2169	18	7·2	157	8·03
...	2218	49	19·6	...	65·5
5.50	2235	17	6·8	180	8·68
...	2281	46	18·4	...	70·6
6.10	2300	19	7·6	168	9·01
...	2349	49	19·6	...	70·5
6.15	2369	20	8·0	182	10·34
...	2416	47	18·8	...	72·8
6.30	2435	19	7·6	177	9·56
...	2484	49	19·6	...	73·9
6.35	2504	20	8·0	177	10·05
...	2558	54	21·6	...	81·3
6.50	2579	21	8·4	168	10·05
...	2625	46	18·4	...	65·8
7.10	2646	21	8·4	162	9·68
...	2691	45	18·0	...	62·0
7.15	2709	18	7·2	155	7·92
...	2758	49	19·6	...	64·7
7.30	2778	20	8·0	174	9·89
...	2828	50	20·0	...	74·1

Table III.

Time.	Planimeter.	Difference mean pressure.	Rev. ÷ 2.	I. H. P.
B. H.	2120	...	...	...
5.30	2151	31	165	36·3
5.35	2181	30	157	33·5
5.45	2206	35	189	33·6
5.50	2237	31	180	39·6
5.55	2269	32	180	40·8
6.15	2300	31	182	40·0
6.20	2325	25	175	31·1
6.30	2356	31	177	38·9
6.35	2388	32	177	40·2
6.50	2421	33	168	39·4
6.55	2450	29	155	31·9
7.10	2482	32	162	36·8
7.15	2512	30	155	33·0
7.30	2545	33	174	40·8
A. H.	...	...	...	...
5.40	2573	28	172	34·2
6.00	2600	27	174	33·4
6.05	2628	28	176	35·0
6.10	2656	28	168	33·4
6.25	2683	27	176	33·7
6.40	2713	30	160	34·1
6.45	2742	29	163	33·6
7.00	2771	29	173	36·2
7.05	2808	29	165	34·0
7.20	2827	27	175	33·6
7.25	2854	27	179	34·3

The slight difference in the measurement produces a divergence in the final result, as follows:—

Mr. Macfarlane Gray shows the mean I.H.P. during the experiments to be 113·98 (and the water evaporated per I.H.P. per hour 22·95 lbs.).

Mr. Liveing shows a mean I.H.P. during the experiments of 110·76 (and the water evaporated per I.H.P. per hour 23·66 lbs.).

The difference is not due to the selection by Mr. Liveing of 24 in place of the whole 48 diagrams, for the same 24 diagrams taken at Mr. Gray's measurement give a mean of 113·26 H.P. against 113·9 H.P. for the whole 48.

Table V. gives Dr. Fleming's measurements of electrical H.P., each of these measurements being taken simultaneously by signal with the corresponding set of indicator diagrams.

Table VI. is compiled from the former Tables for the purpose of showing what percentage of the I.H.P. in the engine cylinders is obtained as useful electrical H.P. at the terminals of the dynamo, and diagram No. VII. shows the same graphically.

For the purpose of compiling Table VI. and Diagram VII. the mean of Mr. Macfarlane Gray's and Mr. Liveing's figures has been taken.

The E.H.P. absorbed in exciting is deducted from the E.H.P. shown on Table V., as would have been the case if the dynamo had been self-exciting and the net E.H.P. is shown in column 5 of Table VI. The efficiency in this table varies from 79 to 66 per cent., the mean throughout the trial showing 74·05 per cent. of the I.H.P. given off as net useful E.H.P. at the terminals of the dynamo.

Table IV.

Willans Engine Tests, Chelmsford, December 12th, 1885.

Diagram.	Time.	Revolutions in half minutes.	Mean pres. of low pres. cylinder.	H.P. of do. × by 2.	Mean pres. of receiver.	H.P. of do. × by 2.	Mr. Gray, by planimeter. Mean pres. of low pres. cylinder.	H.P. of do. × by 2.	Mr. Gray, by planimeter. Mean pres. of receiver.	H.P. of do. × by 2.
A L			lbs. sq. in.		lbs. sq. in.		lbs. sq. in.		lbs. sq. in.	
1	5.45	189	16·35	65·65	7·34	9·85	16·0	64·29	7·6	10·2
2	6.5	176	18·38	68·73	7·41	9·26	19·6	73·44	7·6	9·51
3	6.25	176	16·81	62·85	7·59	9·48	16·8	63·00	7·6	9·51
4	6.45	163	18·48	63·99	7·65	8·85	19·2	66·60	7·6	8·80
5	7.5	165	18·60	65·20	7·63	8·93	19·2	67·35	8·0	9·38
6	7.25	179	18·40	70·17	7·38	9·38	19·2	73·20	8·0	10·16
Mean ...	...	...		66·1	...	9·29	...	67·98	...	9·59
B L										
1	5.35	157	19·30	64·38	7·70	8·58	19·6	65·50	7·2	8·03
2	5.50	180	17·55	67·12	7·46	9·53	18·4	70·60	6·8	8·68
3	6.10	168	19·27	68·80	7·55	9·00	19·6	70·50	7·6	9·01
4	6.35	177	21·05	79·15	7·95	9·99	21·6	81·3	8·0	10·05
5	6.50	168	19·50	69·60	8·58	10·23	18·4	65·8	8·4	10·05
6	7.15	155	18·75	61·75	7·22	7·94	19·6	64·7	7·2	7·92
Mean ...	...	...		68·4	...	9·21	...	69·7	...	8·95
			High pres. cylinder.	Pres. of do. × by 2.			High pres. cylinder, Mr. Gray.	H.P. of do. × by 2.		
A H			lbs. sq. in.				lbs. sq. in.			
1	5.40	172	27·10	33·09	...	...	28	34·20	...	...
2	6.0	174	26·35	32·55	...	...	27	33·40	...	...
3	6.20	175	26·25	32·61	...	...	25	31·10	...	...
4	6.40	170	29·00	35·00	...	...	30	34·10	...	...
5	7.0	176	27·60	34·48	...	...	29	36·20	...	...
6	7.20	175	25·60	31·80	...	...	27	33·69	...	...
Mean ...	...	...		33·25	...	...	...	33·7	...	...
B H										
1	5.30	165	30·30	35·49	...	...	31	36·30	...	...
2	5.50	180	29·70	37·95	...	...	31	39·60	...	...
3	6.15	182	28·60	36·95	...	...	31	40·00	...	...
4	6.30	177	29·45	37·00	...	...	31	38·90	...	...
5	6.55	155	28·85	31·74	...	...	29	31·90	...	...
6	7.15	155	29·52	32·49	...	...	30	33·00	...	...
Mean ...	...	...		35·27	...	...	...	36·60	...	...

Table V.—Dynamo Economy Trials.

Time.	Corrected current.	E.M.F. corrected to brushes.	Watts.	E. H. P.
5.30	124·3	530	65,879	88·31
5.35	119·1	492	58,597	78·53
5.40	120·	487	58,440	78·34
5.45	124·3	522	64,884	86·97
5.50	120·	501	60,120	80·59
5.55	129·5	551	71,354	95·65
6.0	123·1	513	63,150	84·65
6.5	125·3	522	65,406	87·68
6.10	124·3	492	61,155	85·02
6.15	129·5	524	67,858	90·06
6.20	127·4	508	64,719	86·75
6.25	123·1	475	58,472	78·38
6.30	130·5	528	68,904	92·36
6.35	129·5	513	66,433	89·05
6.40	124·3	496	61,652	82·64
6.45	124·3	481	59,788	80·14
6.50	126·3	497	62,771	84·14
6.55	121·2	465	56,358	75·57
7.0	131·5	522	68,643	92·01
7.5	128·4	496	63,686	85·37
7.10	123·1	461	56,749	76·07
7.15	122·2	455	55,601	74·53
7.20	129·5	511	66,174	88·70
7.25	129·5	508	65,786	88·18
7.30	129·5	512	66,304	88·89
			Total	2118·58
			Mean	84·74

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TABLE VI.—COMBINED ECONOMY TRIALS.

Time.	Mean I.H.P.	Electrical H.P.	Extg. electrical H.P.	Electrical H.P. corrected.	Commercial efficiency.
5.30	111·74	88·31	1·9	86·41	77·3
5.35	107·74	78·53	1·79	76·74	71·2
5.40	101·57	78·34	1·63	76·71	75·7
5.45	106·76	86·97	1·28	85·69	79·8
5.50	...	80·59	1·28	79·31	...
5.55	118·05	95·65	1·9	93·75	79·2
6.0	110·62	84·65	1·9	82·75	74·9
6.5	115·47	87·68	1·69	85·99	74·5
6.10	...	85·02	1·53	83·49	...
6.15	117·50	90·06	1·95	88·11	75·1
6.20	113·76	86·75	1·79	84·96	74·8
6.25	106·3	78·38	1·33	77·05	72·8
6.30	123·26	92·36	2·02	90·34	76·
6.35	130·47	89·05	2·26	86·79	66·5
6.40	108·45	82·64	1·85	80·79	74·2
6.45	108·0	80·14	2·15	77·99	73·
6.50	117·24	84·14	2·21	81·93	70·
6.55	...	75·57	1·9	73·67	...
7.0	115·84	92·01	2·1	89·91	78·
7.5	109·48	85·37	2·26	83·11	76·6
7.10	108·48	76·07	1·9	74·17	68·2
7.15	103·9	74·53	1·9	72·63	70·
7.20	112·54	88·70	1·85	86·85	77·1
7.25	115·7	88·18	1·63	86·55	75·
7.30	124·79	88·89	1·79	87·10	69·8
Total ...	2477·67	2118·58	45·71	2072·79	1629·1
Mean ...	112·62	84·74	1·83	82·91	74·05

It was originally intended to make the trial of four hours' duration, but it was found difficult at first to make the times of the indicator diagrams coincide exactly with those of the electrical readings. The early ones were therefore rejected, and

CURVES OF ELECTRICAL OUTPUT AND MECHANICAL INDICATED HORSE-POWER OF VIENNA DYNAMO (No. 1123) AND EXCITER.

No. 1 = *Electrical H.P. of* $\frac{12}{600}$. *No.* 2 = *Indicated H.P. of large Willans Engine.* *No.* 3 = *Electrical H.P. of* $\frac{12}{600}$,—*Exciter E.H.P.*

those of the last two hours only taken. It will be seen from the diagram, No. VII., that there was considerable variation in the H.P., the cause being that both the large engine and the exciting engine were incomplete, being intended for use with electric governors, which were not ready in time for the trials, moreover, the load being a heavy one for the boilers, the steam pressure at first was not kept very regularly. Owing to the system adopted of weighing the water it was possible to obtain with the utmost exactness the quantity used during the two hours of the trial, but this could not be the case with the coal, as the quantity was weighed out for the whole run. However, dividing the total weight of water evaporated during the four hours by the coal consumed during the same period we find that 7·42 lbs. of water only were evaporated per lb. of coal. The total weight of water evaporated during the actual trial, lasting 2 hours 2 minutes, was 5,320 lbs., therefore, the results in lbs. of water per H.P. and per E.H.P. per hour—viz., 23·2 lbs. and 31·31 lbs. respectively—are exceedingly good, in fact there are no published results which show even an approximate approach to this measure of steam consumption per E.H.P.

Good though these results are, it would hardly be fair either to the engine or dynamo to take them as representing their maximum efficiency, for the boilers were not sufficiently powerful for the work and could not be cleaned for the trials; it is, therefore, more correct to eliminate the boilers from the calculation by taking the steam used, instead of the coal, though even then an error creeps in, as the steam was probably rather wet from insensible priming, due to the forcing of the boilers. Moreover, the condensation in the steam-pipes was considerable, owing to the temporary nature of the connections. When these drawbacks are taken into account, and it is further considered that it was apparent from the indicator diagrams taken during the trial that far greater economical results would have been obtained at a higher H.P. had the boilers permitted it, there seem fair grounds for expecting a consumption little exceeding 20 lbs. of steam per I.H.P. per hour, or 27 lbs. per E.H.P. per hour, and this with a good boiler is equal to 2 lbs. and 2·7 lbs. of coal respectively. Boiler pressure, 130 to 140 lbs.

In cases where a condenser can be used, there would be a further increase in the economy.

These trials show that the view held for so many years that a high-speed engine must necessarily be wasteful, must be definitely given up, for in this case we have a high-speed engine showing under not the most favourable circumstances an economical use of steam which need not fear comparison with that of any other slow speed steam engine; but it is capable, as has been shown, of still further improvements.

The bearing of this fact upon the future of electric lighting is most important. A great step has been made in the direction of economical production of electrical energy from the fuel, and it seems probable that the typical dynamo of the future for large installations must be one driven direct by a high-speed steam-engine of from 150 to 200 horse-power.

(Signed) J. MACFARLANE GRAY.
J. A FLEMING.
E. H LIVEING.

THE JUDGMENT IN THE TELEPHONE CASE.

THE *Pall Mall Gazette* says:—" Mr. Justice North delivered on Saturday last a judgment in a telephone suit which indicates a strange perseverance in the mischievous practice of enlarging in favour of a powerful monopoly the claims of a patentee. The patentee in this case was the notorious Edison, whose sole claim respecting that part of the telephone which goes by his name is defined by the words, 'I claim as my invention the combination' (in this instrument) 'with a diaphragm or tympan of electric tension regulators.' The instrument of Edison consists of several parts—'the diaphragm,' the 'tension regulator,' the mouth 'tube,' and the 'adjusting screw;' but he disclaims any right to the latter details. A Mr. Bassano, a small telegraph engineer of Derby, had ingeniously devised a telephone in which the mouth tube was retained, with the regulator, but without the diaphragm. Mr. Justice North has, however, decided that because a tube can be made to discharge the functions of the diaphragm, therefore it is a diaphragm, and condemned Mr. Bassano in a long-winded judgment requiring nearly an hour for delivery. We recommend to Mr. Justice North the following argument: A horse can be used in combination with a cart, but a steam engine can be used to discharge the same functions as the horse. Therefore the man who uses a steam engine infringes the use of a horse. Only in this case the combination cannot be patented.

" The extraordinary reason given by Mr. Justice North for thus stretching beyond all right and reason the meaning of the perfectly plain term 'diaphragm' was that Edison, being the original and first inventor of the telephone, had the utmost right to protection. The real fact which Mr. Justice North ought to have known is this: that in 1876, when Graham Bell's telephone was

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making a sensation in the States, the then president of the Western Union Telegraph Company, the Hon. William Orton, came to Mr. Edison, then an operator in their employ, bringing with him a manuscript account of Philip Reis's much earlier telephone of 1861, and begged him to construct a telephone on the basis of Reis's telephone, so as to out-rival Graham Bell. Edison stated this on oath several years afterwards. Yet this is the man in whose favour Justice North stretches the term 'diaphragm' so as to include, not only a speaking tube, but everything else through or at which one can speak to a telephone. The doctrine of 'benevolent construction,' as the lawyers put it, in patent cases is always and essentially unjust. It is unjust to the patentee to interpret his claims so as to limit them to less than what he is entitled to. It is equally unjust to the public and to other inventors to widen them beyond the meaning of the inventor's own words."

LEGAL.

The United Telephone Company v. Bassano (before Mr. Justice Pearson).—This was a summons in the nature of an interpleader action to determine a question under the apparent possession clause of the existing bankruptcy statutory law though under the accident of circumstances the summons was actually taken out in a patent action. Messrs. Bassano and Slater were manufacturers of telephonic instruments at Webster's Yard, Traffic Street, Derby. They were made defendants to an action by the United Telephone Company. Judgment was given against them, with costs. The costs amounted to £1,200. The plaintiffs got them taxed, and proceeded to enforce payment by levying execution. The chattels of the defendants on their premises were seized by the sheriff in November last. On the day following the defendants presented a petition in bankruptcy, and a receiver in bankruptcy of their estate was appointed. Previously to that Messrs. Bassano and Slater had executed a bill of sale to a Miss Oakes of all their stock-in-trade and plant, and notices of claim were given to the sheriff on behalf of both the receiver in bankruptcy and Miss Oakes. The sheriff took out an interpleader summons to determine which of the three parties, the execution creditors, the receiver in bankruptcy, or the assignee under the bill of sale, were entitled. The United Telephone Company and the receiver impeached Miss Oakes's title on very similar grounds, and the former admitted that if they were right the receiver was entitled before them. So the question lay substantially between Miss Oakes and the general creditors as represented by the receiver. The validity of the assignment to Miss Oakes was disputed because it did not in form comply with all the requisites of the existing statutory law affecting bills of sale, and also as being fraudulent under the Act of Elizabeth. His Lordship held that the assignment was not fraudulent, and acquitted Miss Oakes from any imputation of not having acted *bonâ fide;* but held, on the authority of a number of cases, that the bill of sale was void. But there was a third question—the really substantial question in the case. Miss Oakes asserted that she had a title by reason of her having actually taken possession of the chattels sold to her, and the point was whether, under the circumstances, the goods were, within the meaning of the Bankruptcy Act, in the order and disposition of Messrs. Bassano and Slater at the time the bankruptcy petition was presented. At the date of the bill of sale there was a contemporaneous agreement that Miss Oakes should carry on the business for herself and employ Messrs. Bassano & Slater as servants, paying them each a weekly salary of £2. The key of the premises was given to her, and some articles were taken away by her. A circular was sent to certain creditors intimating that the firm had been changed to Bassano, Slater and Oakes. The business was to some extent carried on after that date. Certain payments were made by an agent of Miss Oakes on behalf of the business, including the weekly salaries of the defendants. Mr. Micklem appeared for the United Telephone Company; Mr. Yate Lee for the receiver; and Mr. Alfred Cock for Miss Oakes. Mr. Justice Pearson, on Saturday, held that the goods were in the apparent possession of the bankrupts at the time of the commencement of the bankruptcy, and belonged to the receiver.

Electric Church Bells.—The special points in connection with the Jensen electric bell system are generally known, but a recent application is to adapt these bells for use in church towers. The gong is of the ordinary church bell pattern, and the coil, armature, and hammer are all contained inside it. The example which has been brought under our notice weighs 60 lbs., and the size of the dome is equivalent to an ordinary hemispherical dome of 22 inches. It is said that with this form of bell the work of the old-established bellringer will be very much lightened, for he could ring a whole peal by alternately pressing the proper keys. The system has been introduced by the Woodhouse and Rawson Electric Supply Company of Great Britain, Limited.

NOTES.

The Electric Light in Stockport.—Some time ago it was mentioned that Mr. T. W. Blackshaw, of the Bridge Street Restaurant, Stockport, had fitted his premises with electric lighting apparatus, but that the driving power then available was insufficient to produce satisfactory results. With a view to giving the system a fair trial, he has had a new horizontal engine put down, capable of giving 12 H.P. with steam indicating 80 lbs. pressure. The boiler and engine were manufactured by Messrs. Marshall, Sons, and Co., Limited, of Gainsborough. The apparatus for lighting was put in by Messrs. G. Durham and Co. The premises are completely furnished throughout with Woodhouse and Rawson incandescent lamps. In a convenient position there are 40 Elwell-Parker accumulators, in which a good supply of electrical energy is stored for use as required; by this arrangement, during summer, when the light is little used, it will probably be necessary to run the engine only once a week in order to re-charge the accumulators.

The Electric Light in the Royal Navy.—Commander Crawford J. M. Conybeare, representing the Admiralty, has made an examination of the torpedo and electric light fittings on board the *Amphion*, 10, cruiser, Staff-Commander Gwynne, at Keyham. The testing of the electric search lights proved a great success, the dockyard and harbour being brilliantly illuminated. Commander Conybeare has also conducted similar trials on board the *Curlew*, gun and torpedo vessel, Lieut. W. H. P. Buckner, with equally satisfactory results.

Electric Lighting in Greenock Harbour.—At the last monthly meeting of the Greenock Harbour Trust, the sub-committee appointed to consider the question of the method of lighting to be adopted at the James Watt Dock submitted their report. It is proposed to light it by the electric light, with seven arc lamps, each of 2000 candle-power, erected on iron four-tubed lamp-posts, 30 feet high, which, with the Brush dynamo and the engine and cables, would cost £786. The cost of maintaining the system was estimated to amount to £150 per annum, whilst the cost of gas would be £100. They agreed, however, to light the sheds and warehouses by gas. The report was adopted, and remitted back to the committee to carry out the arrangements referred to therein.

Ship Lighting.—Last week, a magnificent steel auxiliary steam yacht, named the *Miranda*, was launched from Messrs. Ramage and Ferguson's yard at Leith for Sir George Curtis Lampson, Bart., commodore of the Royal London Yacht Club. Electric lighting by Messrs. Siemens Bros. and Co. is to be used all over the vessel, the number of separate lights being about 60 in all.

Messrs. Henry Bennet and Co., Glasgow, have been entrusted with the electric lighting of the handsome steel paddle steamer *Edinburgh Castle*, just launched. The steamer is intended for pleasure sailing on the Firth of Forth.

The Gulcher System.—The Gulcher Electric Light and Power Company has recently erected for Messrs. Jonas Brook and Brothers, Meltham Mills, Yorkshire, one of the largest installations of incandescent lamps carried out in Yorkshire. The 260 lamps in this installation are of Swan-Edison 90 volt type, and the current is generated by a No. 5 Gulcher compound wound dynamo of the latest and most improved pattern, and capable of giving a current of 220 ampères at 100 volts E.M.F., or an electrical output of 22,000 watts at a speed of 500 revolutions per minute, so that it is large enough to enable the lighting to be extended should Messrs. Brook Bros. so desire. The motive power for driving the dynamo is taken from the main line shaft, which is fitted with a friction pulley; this avoids the inconvenience of fast and loose

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pulleys and striking gear, and answers the purpose admirably. The lamps are all suspended from the ceiling by means of long wrought iron pendants, and, in order to obtain the utmost effect from the lamps, each is fitted with an opal reflector 6 in. in diameter. This installation is the third of the Gulcher Company's system which Messrs. Brook Bros. have adopted. The second installation was supplied for lighting their Royde Edge Mills, where a No. 4 compound wound dynamo is used to run six arc lamps in the dye houses and 20 incandescent lamps in the different departments. As this installation will ultimately be extended, the dynamo machine is capable of running 60 more incandescent lamps of 20 C.P. This installation shows the advantage of the Gulcher system of electric lighting for factory work, as it enables arc lamps to be used in dye houses or larger buildings and incandescent lamps in the small rooms or departments, both being driven from one dynamo machine, and, in fact, from the same arrangement of circuits. The system has already been adopted largely in Yorkshire, and the following may be mentioned as the most prominent firms :—Messrs. James Watkinson and Son, Holmfirth ; J. Sykes and Co., Brockholes ; and E. Fox and Sons, Dewsbury.

Taunton and the Electric Light. — At a recent meeting of the Taunton Market Trustees, Mr. A. G. Massingham, who has undertaken the introduction of the Thomson-Houston system of electric light into Taunton, wrote stating that he thought it would be a great misfortune if the centre of the town remained in its present position as regarded lighting. Rather than it should remain in a state of semi-darkness he should be pleased to provide 7 arc lamps of 1,200 candle-power each, and keep them burning until 11 p.m. until Christmas (when the contract of the gas company expires), free of cost, if the trustees would pay the expenses of the electric engineer in fitting up the lamps, &c. The cost for wiring was £80 per mile, which would include fixing the lamps on the posts. The trustees were of opinion that as they were already paying the Town Council for lighting the town with gas, they could not expend any further sum in that direction, but it was resolved to give Mr. Massingham permission to erect the posts and necessary fixtures on the Parade, and also to contribute £10 towards the expenses of fitting (estimated by several members at £20). A hope was expressed that the Town Council would subscribe the other £10.

The Electric Lighting Bills.—A meeting of the Association of Municipal Corporations was held in the Westminster Palace Hotel last week to consider the three electric lighting bills which the House of Lords have sent to a Select Committee. Sir George Morrison (the town clerk of Leeds), explained that at a joint meeting of the Parliamentary and Electric Lighting Committees of Leeds, it was determined to support the Government Bill, which, it will be remembered, practically extends the period of purchase from 21 to 42 years. Sir George Morrison moved that the meeting should accept a similar resolution. This was agreed to with the rider that a clause be added asking the Government to make the consent of a Corporation an essential condition to a provisional order being granted to a company. It was also resolved that the town clerks of Leeds, Nottingham, and Birmingham, and representatives from the corporations of Liverpool, Manchester, Blackburn, and Sheffield be requested to give evidence in support of the resolution of the association before the Lords' Committee.

Lord Ravensworth last week presented a petition to the House of Lords from the Mayor and Corporation of Newcastle-on-Tyne against the Electric Lighting Bills of Lord Rayleigh and Lord Bury, and against certain provisions of the Government Bill on the same subject. Lord Ashford (Viscount Bury) has presented petitions from Messrs. Crompton and others, and the Dynamicable Society, against the Goverment Bill, and praying to be heard by counsel before the Select Committee. The Electric Lighting Act Committee has also drawn up a petition, which is shortly to be presented, against the Government Bill and in support of Lord Rayleigh's Bill, and praying to be heard by counsel.

New Telephones.—Our esteemed American contemporary, the *Electrical World*, to whose columns we are indebted for our description of the new forms of telephonic instruments shown on pp. 343–344, makes the following comments thereon :—"It is well known that with carbon electrodes only two or three cells can be used for telephonic transmission, and any increase in the number results in a loss of efficiency. The reason is, that a heavier current than is represented by that number of cells causes a burning of the carbon as well as a sparking, due to the slight movements of the carbon electrodes. The spark allows of the continuous passage of the current, and prevents the *sudden* variation which is essential to good effect in a telephone receiver. It is evident, then, that the primary current in the carbon transmitter is of necessity limited to a very weak one, and all attempts to increase the number of batteries allowable have failed for the reason above given. If, with platinum contacts, the same percentage of variation in resistance can be obtained as with carbon, a great point has been gained. We may then construct telephone receivers of a more robust nature, so that they will not be influenced by weak currents, and most of the induction troubles will be at an end. In the lack of practical information regarding the efficiency of the platinum contact, it would be injudicious to carry our reflections further. It must be borne in mind that the mere substitution of a heavy current for a weak one in the transmitter is in itself no gain. But if the heavy current can be varied in the same degree as the weak one, then a decided improvement has been made. To substantiate our statements in regard to the use of a more hardy receiver, we would refer to Mr. Bergmann's telephone, illustrated on another page, and in which the currents travel axially through the magnets, no coils being used. Such a receiver would hardly, in our opinion, detect the presence of induction currents, and the ordinary telephone current would probably affect it in but a very small degree. But with a strong current made possible by the new transmitter, such an arrangement might prove highly efficient and serve the object for which it was designed." The *Electrical World* is right ; the requisite telephonic instruments are, a less sensitive receiver than the Bell, and a transmitter which can be made to vary heavier currents.

A Combined Mechanical and Electrical Telephone.—Messrs. G. Durham and Co. have brought out a combination apparatus, which is said to be successful and practical. The following vague description has been sent to us by the above firm : "It consists of a number of 'sound chambers,' one influencing the other to such a degree that by placing a cone shaped funnel of stiff material, such as metal, in front of the transmitting box, the sounds are given out, and every word can be distinctly and clearly heard at a distance of several yards from the instrument. By taking away the cone and placing an ordinary ear piece and flexible tube (as in the Gower-Bell) every sound is perfectly private, a whisper being successfully reproduced when the line is not over an unreasonable distance. The electric currents are passed from a switch to the vibrating plates, and through the sound chambers to the distant station. These electrical charges and discharges can be conveyed over a considerable length of line. The line for conveying vibrations can, with careful fixing, be successfully worked over a considerable astonishing distance." They are in operation at the extensive hat works of Messrs. Christy and Co., Stockport.

Telephone Posts and Wires.—The Bournemouth Commissioners at their last meeting passed a draft agreement with the Western Counties and South Wales Telephone Company, permitting the latter to erect posts in several roads under their jurisdiction.

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Telephone Charges.—Mr. Chas. Lever, whose pen is ever active, so much so, indeed, that we fear he does not always think calmly over the matters which rouse his ire, has sent a lengthy communication to the Manchester *Guardian*, of April 2nd, on the subject of telephone charges. Prof. Silvanus Thompson's instruments are cited as being without the pale of the Edison-Bell claims, and Mr. Lever concludes, without any grounds for so doing, as follows :—"The fact is that the United Telephone Company cannot and will not attack Prof. Thompson's Valve telephone in the face of the scientific evidence which can be produced as to the non-infringement of the same. Already the telephone monopoly, both in this country and in the United States, is on its last legs. And when this structure of telephone monopoly at last goes reeling and toppling over we shall not be at all sorry, but we shall gladly hail the day that brings us free trade in telephones."

Our views on this monopoly question are too well known to need restating, but we should be blind indeed, even to the extent of groping in the darkness which surrounds Mr. Lever, if we went so far as to say that the U. T. Company cannot and will not attack the Valve telephone. With the judgments of Lord MacLaren and of Justices Fry and North in their favour, why should the company fear the issue of a legal contest with the owners of Prof. Thompson's instruments ? Is not the case supporting the Valve transmitter, the tube leading to it, in short the entire combination, in the light of their judgment, a diaphragm ? Mr. Lever, ourselves, and others who would gladly hail free trade in telephony, might write till doomsday, but with what object, when our legal luminaries uphold the monopoly ?

Electricity on Board a New Japanese Cruiser.—There arrived in Plymouth Sound last week the *Naniwa Kan*, a newly-constructed cruiser of the most modern type, built on the Tyne for the Japanese Government. The two engine rooms, which are so constructed that during an action or in case of any emergency they can be made watertight, are beautifully illuminated with Swan incandescent electric lights, and the coal bunks, stokeholes, and captain's saloon are similarly lighted. On the bridge of the vessel there is a circular conning tower, from which the captain can himself steer the ship by electricity. At either end of the bridge are two electric search lights of great power and brilliancy, and about midway between these are a steering apparatus for the officer on watch, and an engine room telegraph. Forward and aft on each broadside are torpedo projecting stations. An electric battery is employed to fire the torpedo at the right moment. This vessel has cost nearly half a million of money.

The Edinburgh Exhibition. — It has now been decided to lay down the electric tramway between the east and west gates on the north side of the grounds—a distance of fully a quarter of a mile. The line will be single, and the cars will make trips backwards and forwards on it. The committee met on Saturday to consider whether they will let out the railway on contract or manage it themselves.

On Monday night an experiment was made with the Thomson-Houston electric light system, in the presence of the Lord Dean of Guild Gowans, chairman of the executive ; Mr. Carey, C.E., engineer for the exhibition ; Mr. W. A. Bryson, electrician ; and Mr. Ellis, representative for Messrs. Robey & Co. It is only about a fortnight since Messrs. Robey & Co.'s engines were placed in position, and last week the dynamo-electric machines in connection with these engines were received from America. The result of the experiment was regarded as highly satisfactory, and the trial was made with the view of carrying on the work at night if necessary. Electricians may feel interested in the statement that these dynamos were received in pieces from the factory in America, and have been fitted together without any preliminary testing.

The Valve Telephone.—Messrs. George Durham and Co. have fitted up a communication by telephone for Mr. Blackshaw, of Stockport, between his residence and restaurant, a distance of 1½ miles. The apparatus is said to work very satisfactorily, the speaking being clear and loud. The firm has also fitted a set for Mr, Brook, of the same place, who gives his opinion greatly in their favour.

Electric Locomotion Wanted.—On Monday last a steam engine and car belonging to the Birmingham and Midland Tramway Company was travelling down Cape Hill, Birmingham, when one of the steampipes burst, hurling the driver off the foot plate. The engine ran down the hill for some 100 to 150 yards when it ran off at a siding and went over on its side. The car, with a full complement of passengers, luckily kept the rails. The driver was badly scalded about the face and neck.

The Leith Flour Mill Explosion.—Writing to the *Scotsman*, Mr. Charles Lever says :—"The disastrous explosion in a flour mill at Leith, caused by the accidental ignition of the exhaust flour, which is highly inflammable, shows how important it is that all such mills should be lighted by means of electric incandescent lamps. The flour floating about in a corn mill is as liable to cause an explosion as the fluff in a cotton or woollen mill, or the small impalpable dust of a coal mine. There can be no security with gas, oil lamps, or candles in use where inflammable dust is floating about. Many of the flour mills in this country are already lighted by electric glow lamps, the incandescent filaments of which burn in a vacuum. When such a method of lighting is fully appreciated and generally adopted, explosions in flour mills and coal mines, and fires in factories and warehouses, will be less frequent."

Royal Institution of Great Britain.—Amongst the probable arrangements for the Friday evening meetings after Easter a paper is announced for Friday, May 28th, by Prof. Oliver Lodge, D.Sc., on "Electrical Deposition of Dust and Smoke."

Self-Induction Experiments. — The experiments of Mr. Willoughby Smith are, we consider, no proof whatever of the incorrectness of Prof. Hughes conclusions. The results arrived at are just what might be expected when a *galvanometer* is used. When a rapid series of reversals or feeble induction currents of very short duration are sent through a galvanometer, no motion of the needle is observed, because the rate at which the impulses take place is far greater than the rate at which the needle of the instrument can vibrate ; but place a telephone in the circuit, and the action taking place becomes evident at once. If an *electro-dynamometer* be substituted in the place of the galvanometer, the effect of the continual impulses, even if they be reversals, becomes evident by a permanent deflection, since the influence of the currents is always to cause the coil of the instrument to turn in one direction. The figure of merit, however, of the best form of electro-dynamometer is comparatively small, and unless the inductive effects dealt with are very considerable, they would hardly be appreciable on such an instrument ; the telephone, in fact, is at present the only instrument which will enable researches with feeble inductive currents, such as those dealt with by Prof. Hughes, to be examined.

Another Warning.—We are asked to warn the electrical public against a man who has been imposing on several firms of late. His method is to pretend having means of influencing electrical contracts of various kinds, which are purely imaginary. He then extracts money on various pretexts, with which he generally gets drunk. He is a small, stoutish, middle-aged man, with red face, sandy hair and whiskers, and prominent eyes.

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The Silvertown Company.—On account of the loss this company has sustained through the death of Mr. Henderson, the late chairman, the following changes in the Board of Directors were made at the last extraordinary general meeting of the company:—Mr. Matthew Gray, the general manager, has joined the Board as managing director, and Mr. S. W. Silver has become chairman of the company. Mr. Robert Henderson, nephew of the late chairman, and son of the late Mr. Robert Henderson, who, with Mr. S. W. Silver, was one of the originators of the Silvertown Company, has accepted a seat on the Board. His position in the City of London should render him a valuable addition to the Board. Mr. George Henderson, son of the late chairman, has accepted the trusteeship for the debenture holders.

Lightning Conductors.—Four tall chimneys and three oil tanks at the Philipstown Oil Works, Linlithgow, have just been fitted with lightning protectors. Two of the chimneys (160 feet high) have each two copper tape conductors 1 inch by ⅛ inch, terminating in a copper cone-shaped rod with four points. The other two chimneys (120 feet high) have strand conductors of 49 wires with a diameter of ⅝ inch. The oil tanks have each a cable conductor made up of 49 wires and having a diameter of ½ inch. The whole of the metal work on the buildings to which the chimneys belong are connected to the main earthing wire by means of screw couplings and solder. The same firm (Messrs. Post & Son, Greenock) has also protected the tower of Birkwood Mansion House (100 feet high), which was damaged some time ago by lightning, by means of a tape conductor 1¾ inches by ⅛ inch, and terminated by a copper rod with four points carried 10 feet above the stone work. All connections are made by screw couplings.

Quality of Iron in Dynamos.—It is well known, says the *Mechanical World*, what an influence the quality of the iron in the field magnets has upon the ultimate output in a dynamo, and a case in point is mentioned by Mr. Gisbert Kapp, showing how impossible it is to foretell accurately the performance of a dynamo unless the quality of the iron be exactly the same in the manufactured machine as the sample submitted. In the case of two machines manufactured for him there was a difference of electromotive force of 20 per cent. between the two, although the machines were of exactly the same dimensions and treated in the same manner. It was imagined that in the first machine the iron magnets had not been sufficiently annealed in consequence of the shortness of time allowed for the work. A second pair of field magnets were ordered and an extra time allowed for the work, the consequence being that 20 per cent. more electromotive force was obtained.

Resistance of Cast and of Pure Iron.—In making some experiments as to whether there was any connection between the magnetic properties and the electric conductivity of iron, Dr. John Hopkinson was unable to find any, but one interesting result came out, that the electric resistance of the samples of cast iron which he tried was 10 times as great as the electric resistance of pure iron. This result has certain important applications to dynamo machines.

The Heating and Cooling of Insulated Conductors.—Prof. W. A. Anthony, writing to an American contemporary, says:—"In an article in the February *Electrician and Electrical Engineer*, Carl Hering, in speaking of 'some calculations or statements made, that insulated wire will cool more rapidly than naked,' seems to imply a doubt whether such is the fact. A mathematical investigation does show that, under certain conditions, insulated wires will cool more rapidly than naked, and to determine whether these conditions obtain for the insulated wires used in practice, a series of experiments were made last spring and summer at the physical laboratory of the Cornell University, upon nearly all the styles of insulated wire in common use. The experiments were conducted by Mr. J. G. White, who made the matter the subject of a thesis for the degree of doctor, and, as the whole investigation will shortly be published, only the general methods of experiment and the results will be given here. Wires in lengths of about 100 feet, half covered and half naked, of various sizes and styles of insulation, were obtained from the manufacturers. One of these wires being strung up in such a way that the covered and naked portions were equally exposed, a current, increasing in strength from one whose heating effect was inappreciable, to the largest the wire would bear, was sent through the entire length of it, and the resistances of the two portions measured while the current was passing. To provide for the measurement of the resistances the wire was made to form one branch of a Wheatstone's balance, the other branches of which were so arranged as not to be heated by the currents that flowed through them. In *every case* the resistance of the naked wire increased much more rapidly than that of the covered, and, in general, the thicker the insulation, the less the increase in resistance. In the case of a 'Clark's' insulation, for instance, where the wire was 65 mils, and the covering 285 mils in diameter, the increase in resistance due to heating by the current, was, I think, about three times as much for the naked as for the covered portion. I was myself surprised to find that the effect of the covering to keep the wire cool, was the general, and not the exceptional effect. In what respect a covered wire differs from a covered steam pipe, will appear when the complete account of this investigation is published."

An Ancient Electric Locomotive.—Professor Page made a trial trip with his electro-magnetic locomotive on Tuesday, April 29, 1851, starting from Washington. The progress of the locomotive was at first so slow that a boy was enabled to keep pace with it for several hundred feet. But the speed was soon increased, and Bladensburg, a distance of, I believe, about five miles and a quarter, was reached in thirty-nine minutes. When within two miles of that place, the power of the battery being fully up, the locomotive began to run, on nearly a level, at the rate of nineteen miles an hour. This velocity was continued for a mile, when one of the cells cracked entirely open, which caused the acids to intermix, and as a consequence, the propelling power was partially weakened. Two of the other cells subsequently met with a similar disaster. Seven halts were made, occupying in all forty minutes. But, notwithstanding these hindrances and delays, the trip to and from Bladensburg was accomplished in one minute less than two hours. The great point established was, that a locomotive on the principle of Professor Page could be made to travel nineteen miles an hour. But it was found on subsequent trials that the least jolt, such as that caused by the end of a rail a little above the level, throw the batteries out of working order, and the result was a halt. This defect could not be overcome, and Professor Page reluctantly abandoned his discovery.—*Ben. Perley Poore, in the Boston Budget.*

Society of Arts Lectures.—Prof. George Forbes is delivering a series of elementary lectures on "Electricity" at the Society of Arts on Saturday afternoons. The first and second have been given, the subjects being "Electromotive Force and Potential," and "Currents and Resistances." Others will be: May 1st, "Magnetism;" May 8th, "Electro-magnetic Phenomena;" May 15th, "Induction;" and May 22nd, "Electrical Measurement."

Sale of Electrical Plant.—Intending purchasers of electrical plant will doubtless find an excellent opportunity by attending the sale of the effects of the British Electric Light Company, which will be conducted by Messrs. Wheatley Kirk, Price, and Goulty, at Turk's Head Yard, Turnmill Street, E.C., next Tuesday.

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Colonial and Indian Exhibition.—A meeting of the Reception Committee was held on Monday, at the Society of Arts. The Committee considered a report from the sub-committee as to the arrangements which could be made for excursions for Colonial and Indian visitors. Mr. Somers Vine, the Official Agent of the Exhibition, attended, and reported to the committee the arrangements which had been made with the railway companies with the view of affording extended facilities for railway travelling to all Colonial and Indian visitors coming to the Exhibition. The chairman reported that, in accordance with the wishes of the committee, and with the approval of H.R.H. the Prince of Wales, he had communicated with the mayors of some of the chief provincial cities, asking if they would arrange for visits of parties of distinguished visitors. It was resolved that a subscription list should be opened; and the hope was expressed that those who have enjoyed the benefit of Colonial hospitality will avail themselves of this opportunity of contributing to the entertainment of those who come to England, from the Colonies and from India, for the purpose of visiting the Exhibition.

The first meeting of the Conference Committee appointed by H.R.H. the Prince of Wales, the Executive President of the Royal Commission, was held on Tuesday, the 13th inst., at the Society of Arts. The committee considered the question of conferences and lectures at the Exhibition, and appointed a small sub-committee to prepare a scheme. The committee propose to arrange for a series of lectures or papers on the different classes of products illustrated in the Exhibition, and they hope to be able to secure the assistance of qualified experts to deal with such subjects as food resources, timber supply, agricultural resources, textile fibres, &c. It is also proposed to arrange for the reading of papers on the resources of the Colonies individually.

Non-Inflammable Leads.—The Liverpool Telephonic Exchange, of the Lancashire and Cheshire Telephonic Company, was again opened for business on Monday last, and, considering the amount of damage done to the wires and instruments, which were almost completely destroyed by the alarming fire of the previous Wednesday, great activity and energy must have been exercised to have got the place in working order again. Many miles of wire were required to replace the insulated wires, which, from their insulation (gutta percha), were easily destroyed, and, it may be remarked, perhaps fed the flames. However, there was an extraordinary exception which is specially deserving of remark. The Lancashire and Cheshire Company had ordered some lengths of 100-wire telephone cables which was specified to be *non-inflammable*, and a short time before the fire, Messrs. W. T. Glover & Co., of Manchester, supplied them with two lengths of 100 wire gutta percha insulated cables, protected by their patent "non-ignitable" process. From the test room to the switch room numerous gutta percha wires were carried in a wooden troughing, and in this was also placed two portions of the 100-wire non-ignitable cable. The fire broke out in the test room and extended to the switch room, and the troughing was in flames and the contents exposed to intense heat. On examination after the fire had been subdued it was found that the contents of the troughing were completely destroyed with the exception of the "non-ignitable" cables, which proved to have thoroughly resisted the intense heat, and deservedly earned their name. Ordinary telephone cables, from the nature of the insulation and the wrapping, are considered dangerous, as being liable to carry fire from one point to another; but this form of cable has been successfully manufactured to overcome this dangerous fault.

The Varley Patents Proprietory.—We are requested to make known that Mr. S. A. Varley is not in any way connected with the above-mentioned firm.

The Gas Companies and the Electric Light.—At the recent meeting of the Commercial Gas Company, the subject of the electric light came under discussion, one shareholder admitting that the light was "making steady progress, not noisy, but sure." It had, hitherto, stimulated the demand for gas. Another shareholder was sure the gas companies would always be able to undersell the electric light. Mr. Jones, the engineer of the company, also spoke of the cost of electric lighting, and said that the Electric Lighting Exhibition had given a stimulus to the invention of gas burners, with the result that they were now in possession of burners which bid fair to rival the electric light in brilliancy and to surpass it in economy.

The Dissipation of Heat in Wires.—The remarks of Professor Anthony on the heating and cooling of insulated conductors are interesting, but it makes one sad to see the uncertainty still existing upon this subject, and once again we desire to assert that the late Robert Sabine, some years ago, showed most conclusively in these pages, all the effects which have so surprised Professor Anthony.

The Albert Palace Lighting.—Which will be the favoured company for supplying the Albert Palace, Battersea, with steam power and dynamos, together with thirty arc and 3,000 incandescent lamps, for a season lasting four months? We fancy the "People's Caterer" has a sneaking regard for a system which has already served him well.

Communication with Moving Trains.—We shall hope next week to give an illustrated description of the Edison system of telegraphic communication with moving trains. It seems more than probable that the Phelps method which we published some time since anticipates in all respects that of Mr. Edison. Considerable interest is manifested in the States in this revived idea of inductional telegraphy.

Burglar Alarms.—Thieves for the second time within twelve months visited the premises of Mr. Horton, ivory cutter, of Sheffield, the other day; but since the last occasion, Mr. Horton has called in the aid of an electric alarm, with the result that two burglars who this time effected an entrance, caused the electric bell to ring, thus ensuring their capture, which, however, was not accomplished until a terrific struggle had taken place between one of them and a policeman.

Telegrams Insufficiently Addressed.--Lord Wolverton the Postmaster-General, replying to a memorial from Bristol in reference to the requirement recently made for the registration of addresses, says that in consequence of the enormous increase which has taken place since the new rate for telegrams was introduced in the number of telegrams which have been insufficiently addressed, it has been found necessary to discontinue the practice formerly adopted of referring to directories in order to supplement these insufficient addresses. At the same time, the Postmaster-General feels that some distinction ought to be made between cases in which the addresses of telegrams have been intentionally curtailed so as to save expense, and cases in which any vagueness of the address has not been intentional, and he has accordingly given directions that when the sender has evidently done his best to give a full address, a relaxation of the rule is, as far as possible, to be permitted. With regard to a statement in the memorial, to the effect that the action of the department would seem to indicate a desire to compel the public to pay fees for the registration of abbreviated addresses, it is far from Lord Wolverton's wish that the registered abbreviated address system should be extended, and he would much prefer that full addresses should be given.

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Are Secondary Generators Reliable? — We are given to understand that the Gaulard-Gibbs transformers used in the Grosvenor Gallery installation give results anything but satisfactory, and that they are to be replaced by a new type of apparatus designed by Mr. Ferranti, who is now engaged in the endeavour to save this installation from meeting with an untimely end. Mr. Ferranti's transformers will be used in parallel, we believe, after the manner of the Zipernowsky-Déri apparatus, and not in series as employed by Gaulard and Gibbs. Perhaps this projected change explains why it has been such a difficult matter to learn anything definite respecting the working of the Grosvenor Gallery lighting plant.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Manchester and District Edison Electric Light Company, Limited.—The registered office of this company is now situate at 12, Victoria Buildings, Manchester.

Edwin Fox and Co., Limited.—The annual return of this company, made up to the 25th ult., was filed on the 2nd inst. The nominal capital is £50,000 in £10 shares; 3,000 shares are allotted, upon 2,611 of these the full amount has been called, and £5 per share upon the remaining 389 shares. The calls paid amount to £27,750, leaving £305 unpaid.

Elwell-Parker, Limited.—The annual return of this company, made up to the 8th inst., was filed on the 15th inst. The nominal capital is £50,000 in £10 shares; 1,600 shares have been taken up, upon 850 the full amount has been called and paid, and £8 per share upon the remaining 750 shares. The calls paid amount to £14,500.

Telephone Company of Egypt, Limited. — The annual return of this company, made up to the 30th ult., was filed on the 6th inst. The nominal capital is £100,000 divided into 16,000 preference and 4,000 deferred shares of £5 each; 12,071 preferred and 4,000 deferred shares have been taken up. The calls paid amount to £355; the sum of £80,000 being considered as paid upon 12,000 preferred and 4,000 deferred shares.

CITY NOTES, REPORTS, MEETINGS, &c.

Eastern Extension, Australasia and China Telegraph Company, Limited.

THE twenty-fifth ordinary general meeting of this company was held at the Cannon Street Hotel on Wednesday, under the presidency of Mr. John Pender.

Mr. F. E. Hesse, the secretary, having read the notice convening the meeting,

The Chairman stated that the gross receipts for the half year amounted to £247,017, a decrease of £1,070 as compared with the corresponding half of the previous year. During the first part of the half year the receipts compared very favourably with the corresponding period, but in November they began to fall off, and there had been a large monthly decrease since. The Egyptian campaign, the expedition up the Nile, and more recently the Afghan frontier dispute, had caused a great deal of telegraphing, which had saved them from feeling the effects of the long-continued badness of trade, but now that nothing of absorbing interest was transpiring in the East their receipts suffered from the prevailing depression. But trade, although it might languish for a time, never died, and with the revival of trade he expected to see increased receipts. Enquiry had been made with respect to the reserve fund, which now stood at £565,644, and he might say that the policy they were pursuing was, as far as possible, to make the property a sound and permanent investment. They could not have a large dividend and at the same time an increase in the value of their property; but by forming a large reserve fund they placed their company in a strong position; they got a moderate, and, he hoped, a satisfactory dividend; and, at the same time, their property was increasing in value every six months. The directors wished to maintain the company in that position because, as he should have occasion to tell them later, there was threatened opposition, and they could meet that opposition better if they had a good round sum in their exchequer than without it. They were yet in ignorance as to the life of a cable. Twenty years, thirty, and even more, had been suggested; but they had, in their own system, to renew a cable which had only been down for twelve years; this showed the uncertainty of this class of property, and, until they knew more about it, it would be infinitely better for all concerned to go on adding to the reserve fund. A total of £36,076 had practically been expended during the half-year in renewing certain sections of the system. Negociations had been going on for some time with the Australian colonies with regard to the reduction of tariffs, and the company had decided to make a substantial reduction in the rate to Australia and China, to take effect from July 1st. For Australia they were going to reduce from 10s. 8d. to 9s. 4d. per word, and for China from 8s. 4d. to 7s. 1d. They had hoped that the negociations with the Indian Government would have resulted in the lowering of the high transit rate, so that a reduction of 2s. per word to Australia might have been brought about, but their efforts had been unsuccessful. The Indian Government seemed, however, inclined to re-open negociations, and possibly a better arrangement might be made with respect to the traffic across India. They had offered the Australian colonies a further reduction of 1s. 4d. per word provided they would extend the period of the subsidy of £32,000 which they now enjoyed, so that it might run twenty years from the present time instead of only fourteen. New South Wales, South Australia and Western Australia, were prepared to agree to that arrangement; Victoria was as yet in doubt, but Queensland and New Zealand refused to agree because in their opinion the rate ought only to be a fraction of the present charge, and they would do nothing that would tend to discourage the establishment of an opposing system. They had been blamed for not giving the Colonies the whole reduction without any reference to their income; of course, it was very well to ask for those benefits, but there were always two sides to a bargain, and he hoped that any bargain the directors might make would be made in the interests of the shareholders and also of the telegraphing public. The reductions contemplated would cause an immediate loss of £62,000, and against that, if the extension of the subsidy took place, they would have £32,000 a year for six years, and during that six years he hoped the growth of telegraphy would bring them to about the same point they now occupied. Judging from statements that had appeared in the newspapers it would seem that efforts were being made, by persons who wished the public to believe that they were officially representing the Colonial Governments in this matter, for establishing a second cable to Australia. The routes advocated were: (1) From Queensland to Ceylon, touching at Java or Timor, a length of about 4,500 knots, costing about £787,000; (2) Western Australia to Europe, *viâ* the Mauritius, South Africa and West Coast, a length of about 14,600 knots, costing over £2,500,000; and (3) Brisbane to San Francisco, Vancouver's Island—touching at Honolulu—Feejee and New Caledonia, a length of about 8,000 knots, costing over £1,500,000. The third route seemed to be preferred, but both the Mauritius and Pacific routes presented exceptional difficulties in the way of enormous depths, long stretches of cables, and eventual costly repairs, while, regarding the financial aspect, it did not promise a sufficient return to cover working expenses and amortisation at a 5s. tariff, unless the Colonies were prepared to subsidise the project. These opposition schemes, he believed, were intended to benefit the promoters quite as much as the Colonies, and those promoters who had met with disappointment were showing a great deal of animus. A short time ago, during his absence abroad, a concession by the Government of a cable to the West Coast of Africa came before the House of Commons for approval, a concession which had occupied quite two years to negociate, the negociations having been conducted with a Liberal, then a Conservative, and again a Liberal Government. Perhaps no bargain was ever more carefully considered in the interests of a Government than this particular concession; nevertheless, the Government and himself (Mr. Pender) were taxed with dishonesty in the transaction. Both the Liberal and Conservative members of the Governments, however, so completely answered the insinuations, that nothing was left for him to say about the impotent and abortive attack, except this, that one of the speakers let the cat out of the bag when he said that if the concession were approved, then a proposal which he had in view for connecting Australia by the West Coast of Africa could not be adopted. This proposal was for the cable he had just referred to, which would require to be 14,600 knots in length. The saving to Queensland, if that colony would join in the arrangement proposed, would be about £900, and New Zealand would benefit to the extent of nearly £5,000. It was a mere sentiment which kept them back, the idea that by joining the combination they would be building up a great monopoly, whereas by bringing in another company they would create a competition that must eventually benefit the colonies. Submarine cables formed a class of property, he thought, which should be exempt from competition. The present cables could carry four times the traffic the colonies required of them, and the result of subsidising another system would be that neither would pay. The colonies which paid the larger proportion of the subsidy, however, were willing to support this company, and he had no fear whatever of the future. Their concession from the New Zealand Government expired a short time ago. They had a subsidy of £7,500 from that Government, and renewal of this was now refused. The directors had shown their forbearance by not raising the tariff so far; but they had given the Government notice that on July 1st they would have to deal with the matter.

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He (the chairman) was hopeful that before that time the New Zealand Government would have arrived at a decision which would do away with the necessity of any advance in the rate. He moved the adoption of the report and accounts, and the payment of a dividend of 2s. 6d. per share and a bonus of 2s. per share, free of income tax, making, with the previous distributions, a total payment of 7 per cent. for the year 1885.

Lord Monck seconded the resolution, which was carried unanimously.

Lord Monck and Sir William McArthur, were re-elected directors, and the auditors, Mr. Henry Dever and Messrs. Quilter, Ball and Co., were reappointed, the meeting thereupon terminating.

The West African Telegraph Company, Limited.

THE prospectus of this company states that the company is formed to connect the West Coast of Africa by telegraph with Europe, under beneficial concessions from the Portuguese and French governments, by means of cables which will touch at the principal places on that coast and be connected with the existing lines of the Spanish National Submarine Telegraph Company, Limited, to the Canary Islands and Cadiz; and with those communicating with the cables of the Brazilian Submarine Telegraph Company, Limited, at the Cape Verd Islands to Lisbon. This company will thus have alternative routes for its traffic with Europe.

The following are the intended stations of the company:— Cables laid and working: Senegal, French; Bolamo, Portuguese; Bissao, Portuguese; Conakry, French. Cables to be laid: Grand Bassam, French; Porto Novo, French; Principe, Portuguese; St. Thomé, Portuguese; Gaboon, French; St. Paul de Loanda, Portuguese.

The length of the cables which will be required to provide a service for the above stations is about 3,600 nautical miles, to be laid for the most part in water of moderate depth; they can therefore be easily repaired if interrupted.

The India Rubber, Gutta Percha, and Telegraph Works Company has transferred to this company the Portuguese concession, and has contracted to manufacture, lay, and deliver the cables (including those already laid), and to equip the stations, for the sum of £500,000.

It is expected that arrangements will be completed by which the cables will be landed and stations opened at the British settlements of Bathurst, Sierra Leone, and Accra, and in connection with which a portion of the Portuguese concession relating to the establishment of telegraphic communication between the Cape Verd Archipelago and the main land (but in no way affecting the guarantee of traffic subsequently referred to) will be disposed of.

The issue of £250,000 share capital will suffice for the present requirements of the company. It is the intention of the directors to issue £300,000 in six per cent. debentures as the work proceeds.

The following will be the sources of the company's income:—

		Per annum.
Portuguese Government 25 years' guarantee of traffic whilst the cables are working, equivalent at the rates stated in the concession to		£42,000
French Government 23 years' subsidy		12,000
Estimated traffic from British and French stations not covered by above guarantee		24,000
		78,000
Deduct working expenses, including transit charges under working arrangements ...	£20,000	
Repair and renewal fund	15,000	
		35,000
Balance		£43,000

or more than sufficient for interest and sinking fund on the £300,000 debentures, and for 7½ per cent. dividend on £250,000 share capital.

The Portuguese Government is entitled to have one-half of the income from the Portuguese stations beyond the amount guaranteed applied in repayment of the sums it may have advanced for the guarantee with interest.

The French subsidy is 75,000 fr., say £3,000, per annum for each of the stations at Conakry, Grand Bassam, Porto Novo, and Gaboon, when placed in connection with Europe, diminishing for any station after its traffic receipts exceed £5,000 per annum, and ceasing when they reach £8,000 per annum. No reduction is made for interruptions of traffic on any section not lasting more than ninety days.

Negotiations are in progress for a further grant of £7,500 a year from the Portuguese Government (guarantee of traffic), and for a subsidy of £2,500 a year from the Belgian Congo State, for stations at their respective settlements near the mouth of the river Congo. The establishment of a station at Ajuda, Portuguese Dahomey, with a subsidy of £1,500 a year, is also under consideration. If these negotiations prove successful, then, deducting £3,500 a year for the expenses of working the three new stations, and interest on capital expenditure for the extensions to them, there would be a net revenue of £8,000 a year beyond the existing guarantees and subsidy.

The value attached by the Portuguese and French governments to their West African possessions is shown by the amounts of their guarantees and sudsidies, while there is every likelihood that other European Governments possessing colonies in the same quarter will before long offer similar inducements in order to have the advantages of cable communication extended to them.

But apart from this there can be no doubt that the activity which has recently been displayed in colonising the West Coast of Africa, and the enterprise which is being exhibited in opening up this hitherto neglected portion of the globe, will speedily lead to a great development of trade. The undeveloped resources of the different regions tapped by this cable hold out the certainty of a growing traffic, ensuring in time a good income over and above the substantial guarantees and subsidies already referred to.

The West Coast of America Telegraph Company, Limited.—We are informed that Mr. Alfred Marshall, formerly partner in the firm of Messrs. F. Huth, Grüning & Co., of Valparaiso and Lima, has been elected chairman of this company in place of the late Mr. Robinson Kendal.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st March are £3,067, as compared with £4,010 in the corresponding period of 1885. The December receipts, estimated at £4,455, realised £4,557.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 9th were £2,369, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held on Thursday, April 8th, Prof. HUGHES, F.R.S., President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, the adjourned discussion on Mr. A. Bernstein's paper on "Electric Lighting by means of Low Resistance Glow Lamps" was continued.

Mr. BERNSTEIN commenced by stating that owing to references to the Thomson-Houston system of electric lighting in the discussion he had arranged for a temporary installation of the same on the present occasion, and a number of arc lights would be shown in operation in connection with an improvised chandelier of his own lamps which would be kept working during the evening.

Mr. WHARTON said that in compliance with Mr. Bernstein's request he had fitted up the temporary installation of the Thomson-Houston system referred to; he was the more ready to do this since several mis-statements had been made at the last meeting with reference to the working of the same. The machine at work was an 18-lighter. With the Thomson machine no compensating resistances were required in the lamps when the latter were extinguished. Incandescence and arc lamps were run on the same circuit; such an installation had recently been put up in a West of England town, and no trouble had occurred.

Dr. FLEMING added his protest against the use of the word "strain" in Mr. Bernstein's paper; one word should not be used to signify two different things. A definite meaning for the word "strain" had been given by Prof. Tait. The word "force" was also very loosely used. The expression "electric strain" had been used by Clerk Maxwell as expressing electrical displacement. Rankine also used the word in the sense of displacement. As regards the qualities of carbons, he would point out that it was well known that heat was more freely radiated from a dead black than from a greyish surface, consequently black, sooty carbon, ought to be better than a grey variety for high efficiency; the fact that the grey carbon was the best for filaments could not, therefore, be due to its colour, but because it was the more refractory variety. He considered the expansion arrangement in Mr. Bernstein's lamp to be a very good one. He could not agree that the finer the filament the more likely it was to have a bad flaw in it. Homogeneity was the important point to be aimed at. The disintegrating effect in filaments he thought was purely a thermal and not an electrical one. The blue glow noticed in lamps was not, he considered, due to the presence of carbonic oxide, it was more probably a phosphorescent effect. He might mention that he had at present in his laboratory an incandescent lamp with a resistance of 900 ohms which took a current of ·1 ampère; this showed how fine it was possible to make filaments; such a fineness would have been deemed impracticable a short time ago. The dangers of the series system were, he believed, about equal to those of the parallel system. The chief difficulty in the former was the insulation of the mains. In America, where the series system was largely adopted, no difficulty was found to exist, as the wires were all aerial ones. Weston lamps were worked on the Philadelphia Railway Station in series with perfect success.

Mr. MORDEY drew attention to the fact that at Brighton, East-

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bourne, and other places, installations of glow lamps had been carried out, and were being successfully conducted on the series system. The lamps used, he believed, were usually of ordinary construction arranged in multiple series, but he understood that, although lamps of such low resistance as Mr. Bernstein had been successful in constructing had not been used, some lamps of comparatively low resistance, made by Mr. Swinburne, had been tried, and he believed with success. These lamps took 3·3 ampères, and were of small candle-power. Groups of three of them were inserted in the circuits of the Brush dynamos. Mr. Wright, of Brighton, Mr. Sayers, who carried out the work at Eastbourne, and Mr. Swinburne were present, and he hoped they would give some account of their experience. He thought the author unnecessarily confined himself to a recommendation of lamps arranged in single series. While these would be useful where it was desired to turn lamps on or off singly, it would often be convenient to use groups of lamps in multiple series. He shared the common belief that it was of the utmost importance that lamps should have long lives. He held this opinion in spite of Mr. Preece's statement that it would be better to work lamps at a higher efficiency and with a shorter life than was usual, and also in spite of Prof. Ayrton's remark that the cost of lamp renewals was a very small item in the total expenses. Cost was not the only consideration. There were serious objections to short-lived lamps, as, for instance, the inconvenience and danger of a room or a railway carriage being placed in sudden darkness. If lamps of high efficiency were used he thought it would be an absolute necessity to provide duplicate lamps or filaments, which would be automatically thrown into circuit in the event of breakage. Although in favour of series working, he pointed out that this system must of necessity give a shorter life of lamps than the parallel system, because in the latter, when lamps became old, the increase in their resistance enabled them to exercise a considerable preservative power—they then took less current—while in the series system, as they were always traversed by the same current, disintegration took place with continually increasing effect, and they approached their death very quickly, and not with diminished candle-power, as was the case with parallel lamps. He supported the author's assumption of the possibility of maintaining the current constant. Constant current was a physical possibility; constant difference of potential in any distribution system was not. Mr. Drake had stated that it was difficult to keep the current constant, and that the Brush regulator for this purpose would not act, but he believed that Mr. Sayers had been quite successful in using this apparatus at Eastbourne, even for glow lamps, and he knew that it could be relied on. He could never understand the position taken by those who so strongly opposed high tension working, the advantages of which were enormous. Mr. Bernstein had done a great service in drawing attention at this time to this question, when, thanks to the teachings of Prof. Forbes and others, electrical engineers were in a position to consider such questions on their merits. He thought the constant-current method had been too much neglected, although he did not suppose that in ships and generally in compact installations it would ever be used, as even in the cost of conductors it would offer little or no advantage, a comparatively heavy wire having to be taken to each lamp, but for long lines the reverse was the case. He thought the author would find that a No. 6 wire was needlessly large for true economy in most cases, but it would be interesting to see what could be done with such a wire. With 10 ampères passing through it, the density of current was only 300 ampères per square inch. The loss would be 14 volts per mile, or equivalent to 2·3 60-watt lamps. This was only a loss equal to a 60-watt lamp for every 750 yards. He thought dynamos giving 3,000 volts could easily be used. The largest Brush dynamo gave nearly that E.M.F., and worked quite well. Such a machine would send 10 ampères through 215 miles of No. 6 wire. For every 750 yards taken off, a 60-watt lamp could be put in. Thus on a circuit of 20 miles 450 lamps could be used, and even with this long line the conductor efficiency would be 90 per cent. He might put it in another way as an illustration, and say that an arc lamp in a lighthouse 210 miles from shore could be worked by such a machine if a cable could be laid with sufficiently good insulation, using an earth return. He thought the objection to high tension on account of the danger was not well grounded—the danger was exaggerated. Although for four or five years he had been engaged daily in working with high-tension dynamos in the works of the Brush Corporation, there had never been a case of personal injury or any accident from an electrical machine, although in the same works there had been several accidents from non-electrical machinery. If the opponents of high tension applied their extreme caution to other things, and carried their case, railways would disappear, and cabs and omnibuses would become a thing of the past, the world would sink to a state of almost absolute zero, when there would be very little motion, and that motion very slow. With regard to automatic cut-outs, he thought electro-magnetic ones were best. Prof. Forbes and others had objected to them on account of the energy absorbed. This was simply a question of construction; the energy required could be reduced to almost any extent. In the cut-out of the Brush lamp, for instance, the energy absorbed was only five-eighths of a watt.

Mr. SWAN thought that Mr. Bernstein had fairly stated the difficulties of the series system, and had fairly grappled with them. He considered that the current in lamps might be decreased with advantage, and the electromotive force increased; less loss would then result. The difficulties of insulation were great, but if these were removed, the other difficulties would easily be got over. Both economy and safety are necessary in cut-outs, and the general appearance of these cut-outs must not be over-looked, as it would not do to have them unsightly.

Mr. WRIGHT mentioned that the high-tension system was in full operation at Brighton, and the maintenance of a constant current was carried out perfectly successfully. No accident had arisen from the use of a high-tension current. Any faults which occurred in the insulation ought to be able to be detected when the current is flowing; this can be done by means of an electrometer. If the potential were reduced when a high resistance was connected to the pole of the dynamo, it would indicate the existence of a fault. A rough plate electrometer was all that was necessary for the purpose.

Mr. VARLEY explained that owing to the loss inside the tube filament, the result with such a filament could not be so good as with a number of fine filaments of the same bulk, unless, indeed, the tube were very thin, which was not the case in the Bernstein lamp.

Mr. MORTIMER EVANS considered that 200 candles per square inch from a filament was the highest power at which a lamp ought to be burnt. A great advantage existed in a thick filament, as a small flaw did not represent so great a percentage reduction in the diameter at that point as in the case of a small filament. The strain on a filament was somewhat similar to that in the case of railway metals, which might be knocked about to almost any extent, so long as the energy of the blows did not exceed a certain limit. It was, in his opinion, actually an advantage to have a mount at each end of the lamp, as in the case of the Bernstein invention.

Mr. SWINBURNE agreed with Mr. Bernstein to a certain extent. If a high volt lamp were run with a low volt lamp to the breaking point, the high volt lamp would go first. Draper's experiments proved that the light emitted from an incandescent surface was quite independent of the nature of the substance from which the light was emitted, so long as the temperature was the same. The blue glow referred to was not, he thought, due to occluded gases. An invisible discharge took place, he believed, in the lamps, no matter how good the vacuum. The roughness or smoothness of the surface of the filaments ought to make no difference in the light emitted. One advantage in a low-tension system was that meters could be used with great ease. The regulation of current in the case of arc lamps was an easy matter. As regards the Thomson-Houston regulator, it was necessary, in order to make it effectual, that the dynamo should have few sections.

Mr. J. MACKENZIE pointed out that if a fault occurred in the case of the series system, it would be impossible to say where the accident happened; moreover, the strain on the machine caused by an accident would be very severe. A series system combined with accumulators would be a most efficient arrangement.

Mr. SAYERS said that the insulation of the underground wires was *the* important point in the series system; but experiment would get over the difficulties which might be encountered. A loop test is easily made in a series system. The Brush current regulator he found to answer very well. An advantage in the series system is that the speed of the engine can be decreased in proportion to the number of lamps cut out.

Mr. BERNSTEIN, in replying, said that the existence of an electric shadow in the lamps proved that the disintegration of the filaments was an electric and not a thermal force. He agreed with Dr. Fleming that the quality of the carbon was an important point. Mr. Mordey's statement that lamps do not work so well in series as in parallel was not correct if the carbons were of proper quality. He did not consider that Draper's experiments prove the point at issue. He had tried the experiment of impregnating the carbon filament with magnesia, but did not obtain any improved effect. He agreed with Mr. Evans that the surface should be polished in order to get the best effect. The question of accumulators, he would point out, had nothing to do with the subject of his paper. As to Mr. Crompton's statement that no constant current machines had yet been made, he had been assured by Mr. Willans that there was no difficulty in this. He would draw attention to the point that, inasmuch as in the series system wires of large diameter for the house leads and lamp leads were necessary, there was smaller probability of an accident from a broken wire than in the parallel system. As regards the Electric Lighting Act, he thought the data there included could only have been obtained from laboratory and not practical experience. It was impossible to say what potential was actually dangerous; he had seen a man knocked down by 50 volts only. In America no accident had ever happened from the use of high tension currents.

The meeting then adjourned.

REPLY OF THE PRESIDENT TO THE DISCUSSION ON HIS INAUGURAL ADDRESS ON SELF-INDUCTION.

Lord Rayleigh, while fully recognising the importance of the subject of my researches, seems not to have seized all the details of the method which I have employed, or the meaning of some of the terms which I have used. Prof. Forbes has already replied to that portion of his remarks; but in his communication dated February 24th, Lord Rayleigh assumes that "the disturbance depends upon the rapidity of vibration, so that, in the case of ordinary mixed sounds, silence can be attained only approximately." Prof. Silvanus Thompson has also asked me if the results depend on the rapidity of the contacts. In reply, I must state that in point of fact the rapidity of the contacts have no influence on the result, providing they are not more rapid than the rise and fall of the extra currents.

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Let us suppose that, instead of rapid contacts, we make and break the contact once only per minute, then, on making or breaking the contact, we shall hear a single blow or tap on the telephone; and if the communications of the bridge and telephone are arranged for the *stable* period, this sound will not be heard when the resistance of the bridge is perfectly adjusted. Suppose that we now change the communications so as to observe the *variable* period, still making and breaking contact but once per minute, we shall then find (if there is self-induction taking place in the wire under observation) that we have no longer silence at the previous adjustment of the bridge; if this disturbance is due only to the extra currents, we can reduce it to zero by throwing in from the sonometer an opposite momentary secondary current of *equal* value; but if the disturbance is due only to the resistance being changed, then we shall have to move the slide on the bridge until we have again perfect silence. In many cases we have to deal only with the extra currents, in others there is a far greater change in the resistance of the wire than in the force of the extra currents. Both can be adjusted separately or alone, but no change of the resistance slide will compensate for the induced currents, nor will any change of the sonometer affect in the slightest degree the required adjustment of the resistance slide; it is the first portion of the current that we are measuring by means of the telephone, or its action at the moment of making or breaking contact.

The object of my researches was to observe what takes place at the first instant of contact. To this the telephone responds with admirable precision, whereas, as I have already said, a galvanometer would be useless for such delicate experiments as I have made, where it is necessary that the self-induction of a few inches of straight wire may be readily perceived and accurately measured. The rate of speed of contacts, therefore, can be increased up to the point where the duration of the contacts is at least as long as the duration of the extra currents. In short wires the duration in time of the extra currents is exceedingly small, and much less than any duration of contact that I have used; a large electro-magnet would require a lengthened contact and a different method. The only advantage, therefore, of short contacts is the constant repetition of sounds or beats, enabling us the more readily and rapidly to find the required balance.

All of the important points mentioned in my paper have been verified by independent methods, and they have also been repeated with slow and rapid contacts, as well as with widely different external resistance in the battery circuit; but I wish to show that the induction bridge gives perfectly reliable results, and that its readings can never be changed or misunderstood.

I have chosen a fine German silver wire for the resistance bridge, because German silver has (even in the form of large wires) an extremely low inductive capacity; and this, when the wire is fine, is again reduced to a mere fraction as compared with what it would be in wires of 1 millimetre diameter of different metals. To test the instrument, place a piece of similar sized German silver wire in the arm, A B, we do not then find any trace of self-induction, as all the four arms of the bridge are equal; we may vary its resistance by shortening the length of the wire, but the bridge can only then be adjusted to zero by moving the resistance slide. Under these conditions there is no difference perceived between the stable and the variable period, as the changes produced are equal on all sides. Let us now replace this German silver wire between A and B by a copper wire of the same resistance, we then find that the stable period gives exactly the same zero as previously, but that a disturbance takes place in the *variable* period, and that this cannot be adjusted by the *resistance* slide, but that it is completely reduced to zero by the opposed induction current of the sonometer. Again, if we heat this same wire its resistance is changed, and can only be compensated by moving the resistance slide; if we make this wire into a loop or a parallel return, there is no change in the resistance, but the *self-induction is reduced* at once, as shown by the sonometer; winding this wire in a coil increases the induction, and, within certain limits, we may perceive no change in its resistance, whilst its *self-induction has increased* several hundred per cent. Now, suppose we increase the resistance by heating and the induction by coiling the wire, we have then two distinct effects of known values, and the measurements given by the resistance slide and by the sonometer are precisely those which would have been given by either when measuring them separately; and this again proves that where we have a case of change of resistance it can only be met by adjusting the resistance slide, and where we are measuring the electromotive force of the extra currents they can only be compensated for by the use of the sonometer.

The cause of the extra or momentary increased resistance of a wire during the variable period can be explained. The current, on entering the wire, produces an extra current of an opposite name, and that this really opposes the passage of the current is proved by the upsetting of the previously balanced bridge; there is, in fact, in this moment less resistance on the opposite side, and the balance can only be restored by the resistance slide.

There are, however, cases where this effect is entirely reversed, in which there is less resistance in the variable than in the stable period; this occurs when we are testing extremely fine wires with powerful currents, for the steady current heats the wire, thus introducing an extra resistance, which does not take place to the same degree with short contacts as in the variable period; but, as I have already said, care must of course be taken to avoid all such sources of error; and if we understand the subject, and know exactly where to look for errors, there should be no difficulty in constructing a bridge perfectly free from experimental error.

The instrument and method which I have employed have a great advantage over any previously used, as from the exquisite sensibility of the former we are enabled, not only to verify all the results obtained by previous observers from their experiments on coils, but to do that which no other instrument or method has previously enabled us to accomplish, viz., to observe the self-induction of straight wires and the laws of its reactions (as in the contiguous portion of the same current in straight wires and sheets) entirely separate and distinct from the mutual reactions of one part of a coil upon another. These I have shown to be quite different, as an iron coil has less self-induction than a copper one, whilst in straight wires the reverse is the case. We must not neglect this all-important point, for in no way do my researches contradict well-known results, they simply go further, and show the physical reasons for certain phenomena; and where theory has failed to predict, or previous experiments to show, this has been due simply to the fact that no instrument existed sensitive enough to record or measure the effects which take place in the self-induction of a comparatively short wire free from external reaction.

Self-induction in coils has been a subject which I had of necessity to study in relation to my printing telegraph instrument. The movement of my armature being extremely rapid, produced extra currents of sufficient force to trouble other instruments on the same line. I finally vanquished this difficulty in 1860 by an arrangement whereby the armature, in rising, instantly short-circuits its own electro-magnet, and by mechanical means (peculiar to the instrument) is entirely separated from the line, placing the line at the same time direct to earth or battery, but leaving the electro-magnet open, so that the return of the armature produces no extra currents that can affect the magnet or line. This has answered perfectly, and has been in use on all of my instruments since 1860 up to the present day. I have also used, since 1861, divided coils, whereby the current is passed through both coils in parallel, and not in series; this I use on lines less than 500 miles, not simply because of the diminished resistance, but because I found from experiments much less disturbing influence from the extra currents. I have, however, lately, by the aid of the induction bridge, been not only enabled to measure this difference, but to trace it to its true cause, and the following table gives a representative result obtained from numerous coils of different sizes and resistances, and with or without iron cores:—

Coils formed of 3 mètres Silk-covered Copper Wire, 1 mm. in diameter, each coil being 3 centimètres diameter.	Comparative Force of the Extra-Currents.
One coil alone	100
Two similar coils in series	174
Two similar coils in parallel, but separated 5 cm. from each other	55
Same two coils in parallel, but superposed ...	81
One single coil of thicker wire of exactly the same form, length, and resistance as the two coils in parallel	75

The table shows an increase of force when two coils are in series, but not quite double, as a portion is reduced by the increased or added resistance. This is a well-known effect; but an interesting result is shown where the two coils are parallel and separated, giving then 32 per cent. less induction than the same coils superposed, and also 26 per cent. less than that of a single coil of precisely the same resistance. We can easily explain this, and trace the effect to the reactions of contiguous coils on each other.

I have shown a remarkable difference in the inductive capacity of different metals when formed into wires of the same diameter; and as the order follows that of their respective specific resistances, it became an interesting study to know what would be the result if all the wires were of the same length and resistance. It is necessary to employ the same length, as the induction increases with the length: consequently a copper wire, compared with a brass wire of equal resistance, and therefore of greater length, would show a great difference in their inductive capacities. There are, however, several methods, free from experimental errors, which I have employed in this investigation.

If we take wires of different non-magnetic metals of the same length and diameter, and reduce them to the same resistance by an added resistance comparatively free from induction, such as carbon, I find that there is apparently no difference whatever in the inductive capacity of the different metals, all (yet tried) giving by this method very nearly the same result; but in this case we have added an external resistance, and thus prevented any difference of action due to the different density of the current in metals of high and low resistance.

If, instead of an added external resistance, we take wires of the same length and resistance, but of different diameters, we then find a marked difference in their inductive capacities; for instance, a pure copper wire, compared with a brass wire of double the diameter, shows a marked higher force in the copper wire. We might naturally believe that the brass wire, from its larger diameter, would give higher results than the smaller copper wire; but if we have thoroughly seized the importance of the phenomenon which I have demonstrated of the reaction of con-

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tiguous portions of the current on each other, we can easily prove that the larger the diameter of the wire the less will be its proportionate reactions, so that, whilst the resistance decreases directly as the increase in section, the reactions of the currents upon each other become *less* as the diameter increases, the resistance diminishing as a straight line, whilst the induction would follow a curve similar to that shown in the diagram.

The following table shows the electromotive force of the extra currents on wires and strips 1 metre in length, a chemically pure copper wire of 1 mm. diameter being taken as the standard of 100, to which all the rest were compared:—

Wires of the same diameter, but of different resistance—1 metre in length.		*Wires* of the same resistance, but of different diameters—1 metre in length.	
Soft Swedish iron ...	500	Soft Swedish iron ...	400
Copper	100	Copper	100
Brass	65	Brass	88
Lead	50	Lead	81

Strips of the same width and thickness, but of different resistance—1 metre in length.		*Strips* of the same resistance and thickness, but of different widths—1 metre in length.		
12 mm. wide, $\frac{1}{10}$ mm. thick.		$\frac{1}{10}$ mm. thick.		
Copper	60	12 mm. wide	Copper	60
Brass	48	42 " "	Brass	45
Iron	45	72 " "	Iron	39
Lead	35	96 " "	Lead	29

In the above table, wires of the same diameter follow in the order of their resistance, iron alone being the exception; the same order is preserved in wires of the same resistance but of different diameters. In the latter case there is a nearer approach to equality, but they still show a difference of from 12 to 19 per cent., and whilst the non-magnetic metals have increased their inductive capacity with increased diameter, iron has fallen 20 per cent.; consequently, wires of different metals of the same resistance have not the same inductive capacity, owing, I believe, to the action of contiguous portions of the current, as I have already shown.

(To be continued.)

NEW PATENTS—1886.

4579. "Apparatus for converting ordinary trembling electric bells into continuous ringing electric bells at will and also for other purposes." H. J. Eck, C. B. Callow, H. Wright. Dated April 1.

4880. "Apparatus to employ electricity for curative and remedial purposes." R. Durling. Dated April 7.

4884. "Dynamo-electric machines." J. Platt, J. Hopkinson, E. Hopkinson. Dated April 7.

4899. "Acoustic telephone ('Beehive')." S. Vyle. Dated April 8.

4915. "Self-acting electric burglar alarms." J. May, G. J. Hutton. Dated April 8.

4937. "Conversion of heat energy into electrical energy and apparatus therefor." W. R. Lake. (Communicated by W. E. Case.) Dated April 8. (*Complete.*)

4939. "Lightning arresters." G. A. Mason. Dated April 8.

4946. "Telephonic and telegraphic call apparatus. C. L. Baker. Dated April 9.

4988. "Electric apparatus." A. Wright. Dated April 10.

5025. "Controlling speed of engines or motors by electricity." J. Richardson, R. H. C. Nevile. Dated April 10.

5063. "Telegraphing apparatus used in connection with steam engines." W. Chadburn. Dated April 12.

5078. "Electric lighting apparatus for use in wheeled vehicles." R. Weber. Dated April 12.

5089. "Electric arc lamps." F. Fesquet, S. J. Comte Ostrorog. Dated April 12.

5090. "Measuring the consumption of electricity." H. Serrin, F. Fesquet. Dated April 12.

5091. "Electrical governors for preventing the racing of marine engines." A. M. Clark. (Communicated by E. A. Wahlström.) Dated April 12.

5092. "Thermo-electric generators." A. Rust. Dated April 12.

5093. "Telegraph transmitters." G. W. Baldridge. Dated April 12. (*Complete.*)

5116. "Electrical toy." R. Dipple. Dated April 13.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

2985. "Improvements in electric arc regulators." J. G. Statter. Dated March 6. 8d. The inventor actuates the improved mechanism by means of a solenoid or by an electro-magnet, either series shunt or compound wound. The power of the solenoid or electro-magnet, as the case may be, is appplied to a link or to two or more links braced together. This arrangement works about a fixed spindle, and bears upon and controls the position of a saddle working in guides, or a guide such as a tube. Brakes (their number being the same as that of the brake wheels) work in bearings attached to the saddle; spindles for the brake wheels are also attached to the saddle and to each break wheel a pinion is rigidly attached. This pinion gears with a rack rod. Each link of the frame has a projection at right angles, or nearly at right angles, to its length forming a bell crank about its bearing and a stud or pin is put into this projection. To this stud or pin the flexible attachment to the brake is fixed, and as the saddle is lifted up by the thrust of the frame upon it the bell crank pulls the brake upon the wheel by means of its pin and flexible attachment. As the link descends the crank moves round, slackens this attachment and raises the brake, allowing the wheel to revolve and the rack rod to descend.

2188. "Improvements in magneto call bell apparatus." H. T. O. Fraser. Dated February 17. 8d. The chief feature of the apparatus is the substitution of a cord chain or other equivalent, in conjunction with a clock spring, India rubber, or any other suitable spring, or elastic substance, for rotating the armature of the generator, in place of the geared or friction wheels or other similar appliances hitherto employed.

2490. "Improvements in apparatus for use in distributing currents of electricity." R. E. B. Crompton. Dated February 24. 8d. Relates to such parts of apparatus used in controlling the supply of currents of electricity as are usually called collecting and dividing switch boards or commutator boards, and consists more particularly in the arrangement and construction of these boards in such manner that all the commutations and connections can be made by comparatively nonsparking and easily renewable switches in place of the plugs or connections of like nature which have hitherto been necessarily used in all the more complicated forms of commutator boards.

2765. "Improvements in and relating to electrical accumulators or secondary batteries." W. R. Lake. (Communicated from abroad by A. Marchenay, of Paris.) Dated March 2. 6d. Relates to electrical accumulators or secondary batteries in which plates of crystallised chloride of lead are employed, and to the preparation of the said plates.

2970. "Improved insulated electric conductor for underground and other purposes." E. W. Lancaster. Dated March 6. 8d. The inventor takes a suitable length of wire or rod of copper or other metal of good conductibility and inserts it either bare or covered with a coating of shellac, paraffin, gutta percha, India rubber, or any other good non-conducting material into a length of dried wood or prepared fibre provided with a groove or slot cut to a suitable size throughout its entire length to receive it. The groove or slot is then filled in flush or covered with a slip of wood which is fixed or glued making the section of the whole length square, angular, or any other shape. The whole is then well dried and soaked in an insulating solution prepared for rendering it perfectly free from dampness or moisture, and so that no such dampness or moisture can penetrate it afterwards. The whole being again dried and tested, is then inserted into a prepared well-dried pipe or tube usually of cast or wrought iron either plain or coated with paint or enamel inside the wood being of square or angular section touches the pipe or tube at the apex of the angles only, and this only at different intervals along the whole length, thus minimising the chance of contracting the copper core with the outer piping. This then leaves segments of unoccupied space throughout the entire length of the pipes or tubes. These are filled under pressure with an insulating and dampproof preparation forcing out all air or moisture that might be in the pipes or tubes providing against any such entering afterwards, or a vacuum may be formed only. The invention also consists of methods of jointing the lengths.

3379. "Improvements in distributing electricity, and apparatus therefor." W. P. Thompson. (Communicated from abroad by C. Zipernowski and M. Déri, both of Budapest.) Dated March 16. 1s. 1d. Induction bobbins are grouped in secondary distributing stations, and the primary bobbins of such a station of second order are intercalated either successively in series or parallelly. In the first case the secondary or induced bobbins of all the stations must form only one local circuit, the induced bobbins may be grouped in quantity or in series. In the other case, when the primary bobbins are arranged parallel, each induced bobbin may form a special secondary circuit, or, as in the first case, all the induced bobbins of such a station may be united to one common local circuit. The places of consumption are intercalated in the local current, in all cases, in a parallel manner. The main rule is, that the several groups of induction bobbins or the different stations of second order form, in reference to the main distributing line of the primary current, always only branch circuits. A distributing net consisting of an optional number of parallelly arranged branch stations, and of an optional number of local cir-

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cuits separated from one another is thus obtained. The stations of second order are made independent from one another by maintaining invariable the tension of the primary current, where it enters into the secondary stations. To obtain an automatic regulation of alternating currents in a satisfactory manner, that is to say, to receive an invariable tension of the current in certain points of the net, even if the effect of the generator and the resistances in the circuit are variable, the following new and simple means are applied. The main current to be regulated is made circulating through the bobbins of a so-called alternating current secondary generator or inductor, before it reaches the working place. The second bobbin is wound parallel to the first round, and a common iron core is intercalated in the exciting circuit. The alternating current indirectly produced by the second spire, that is to say, secondarily induced by the main current is turned into the same direction by a commutator adapted to the shaft of the machine. If the secondary spire is intercalated in the exciting circuit in such a way that the current induced therein is added to the exciting current, the magnetising will change in the same sense as the intensity of the main current. The magnetising will change in the contrary sense, when the secondarily induced current is circulating opposite to the exciting current. The first arrangement serves for regulating the tension of the current, the second arrangement for regulating the intensity thereof.

3599. "Improvements in electro-motors or dynamo-electric machines." A. Reckenzaun. Dated March 20. 8d. Has mainly for its object the production of a novel type and improved construction of field magnets, which are laminated or built up of thin bars or plates, thus ensuring the advantages of rigidity, simplicity and efficiency, combined with small weight of material.

3625. "Improvements in supports for the shades and bulbs of incandescent electric lamps." A. Swan. Dated March 20. 8d. The inventor makes the shade support in two parts, consisting of an outer and an inner tube, the outer tube having a splayed out or conical part, and the inner tube being provided with corresponding arms between which splayed out or conical part and arms the shade is held.

3764. "Improvements in electric fuses." J. Nacnab and D. Hickie. Dated March 24. 11d. Relates to improvements on the present methods of constructing low and high tension electric fuses for the purpose of insuring greater reliability of action and more efficiency in manufacture, also for securing more freedom from damage and better contact between the poles of the same than has hitherto been obtained, besides neutralising any chemical action or decomposition that might take place between the gun-cotton or priming composition employed, and the substances of which the plug or wire holder case is composed.

3765. "Improvements in the manufacture of filaments or carbons for incandescent electric lamps." G. Davidson, R. C. Jackson and J. B. Duncan. Dated March 24. 8d. The material which is to be carbonised to form the filaments is cut into uniform strips by causing it to revolve against a cutting instrument or by causing cutting instruments to rotate against it.

3845. "Improvements in thermo-electric generators and in insulating materials." H. Woodward. Dated March 25. 8d. The improvements have reference, 1st, to the construction and insulation of the chamber or casing of the generator which surmounts the furnace or source of heat; 2nd, to a special form or construction of the elements; 3rd, to the manufacture of a novel material or composition for insulating the elements one from the other, but which material or composition is equally applicable to insulation in other electrical apparatus; and, 4th, to a mode or method of connecting the entire series of elements, or any portion thereof, when built up, with the terminal posts.

3854. "Improvements in electric governors." W. Hartnell. Dated March 25. 11d. The current is made to control the position of an instrument, and this instrument, when it has been correctly placed, is afterwards, by the power of the engine, motor or current itself, applied to move the throttle valve or other mechanical part of the engine or motor, or it may be of the dynamo relay resistance or the like which has to be moved to regulate the current.

3857. "Improvements in electrical switches." S. Z. de Ferranti. Dated March 25. 8d. According to this invention, the inventor makes electrical switches in such a manner that by the first movement of their knob or handle (which has to be turned or moved to make or break a circuit), energy is caused to be stored up in a spring or springs without affecting the contacts until the springs have been brought into such a state of tension or compression that they overpower the resistance which retained them, and that they then fly, or cause other parts to fly, quickly into position to make or to break a circuit as the case may be.

4137. "Improvements in methods for transforming, distributing, controlling, and utilising electric and magnetic force, and in apparatus or means employed therefor or in combination therewith." J. S. Williams. Dated April 1. 6d. Has for its object the dealing with the development, conduction, control, and use of magnetism in a manner analagous to that which is employed in dealing with electricity—or other forces. The inventor constructs electro-magnets or electro-magnetic systems so that their cores, or both cores and conducting or energising elements may at will be coupled (as galvanic batteries or dynamic or other generators are at present, or as other electric appliances, for instance, lamps, &c., are, viz.), in series, compound series of multiple series, or parallel circuit.

CORRESPONDENCE.

Proofs that Electricity is an Element.

Referring to my letter published in your number of the 9th inst., I have some further facts on this subject, which call for attention.

MM. Cailletet and Bouty described before the Paris Academy of Sciences, "numerous experiments made with mercury, silver, tin, aluminium, magnesium, copper, iron, and platina, proving that the electrical resistance of these metals decreases regularly when the temperature is lowered from 0·° to — 123° C., and that the coefficient of variation is apparently much the same for all. They further stated that "it seems probable that the resistance would become extremely slight at temperatures lower than 200°, but they had not carried their experiments so far." The action of the freezing mixture of — 123° C. on a copper wire would be two-fold :—*first*, the normal amount of latent heat within the wire would be greatly reduced ; *second*, the molecules of the copper would be drawn closer together. Notwithstanding that the molecules of the copper would be drawn closer together, and thereby leave less space between or around them for the passage of electricity, yet the resistance to the passage of the electricity through the wire was diminished by the removal of part of the latent heat which was within the copper. This proves that heat is in some way the obstructing element which prevents the free passage of electricity through metals.

There is another important phenomenon bearing on this subject. In the *Scientific American* of the 27th ult., there is a letter to the Editor, from a Mr. Chas. L. Chapin, giving an account of certain engineering operations he was shown in Bermondsey, when he was in this country, in January, 1874. All persons acquainted with engineering know how much time and labour are required in the operation of fixing, on the face plate of a large turning lathe, the pieces of metal which are either to be turned or bored. A Mr. Werdermann formed the idea, and patented the plan of fixing these pieces of metal by means of powerful electro-magnets. These large magnets were arranged on the face plate of the turning lathe, so that when a piece of metal to be turned or bored was placed in its proper position on the face plate, the electricity was then switched on to the electro-magnets, and they advanced and held the piece of metal firmly without any other fastenings, thereby saving much time and labour. Owing to this invention a discovery was made of a phenomenon which Mr. Chapin says has remained unexplained until now, and he has given the information to the Editor of the *Scientific American* in hopes that an explanation will be found. Every scientist knows that Count Rumford's attention was first directed to the study of heat by the very great amount of it which is produced at the boring of a hole through a mass of metal. In the engineering shop in Bermondsey, Mr. Chapin saw masses of iron bored and turned, during which processes neither the bored and turned iron, nor the chips from them, showed any signs of heat, and the tools used in doing the work of turning and boring were so cool that they did not require to have a stream of water kept running on them, as is commonly necessary when this work is done by the common kind of turning lathes. At the end of Mr. Chapin's letter, he writes "Mr. Werdermann's solution of the matter was simply—it was supposed that the heat of the cutting tools was absorbed by the magnetised condition of the iron which formed the keeper of the heads of the magnets." Mr. Chapin adds in his letter, "Was this the true solution ?" I reply, it is so far true, but it does not explain why these iron electro-magnets should absorb an amount of heat which cannot be absorbed by much larger masses of unelectrified iron. The reason why that large amount of heat disappeared was on account of the attraction which electricity has for heat. The currents of electricity passing through the wires of the electro-

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magnets absorbed all the free heat which came within their reach from the metal, when the boring and turning was taking place, and kept the tools cool in consequence.

This discovery of the late Mr. Werdermann places beyond all doubt the fact of the great attraction which electricity has for heat.

Whether electricity and heat be or be not each of them a kind of imponderable matter it is manifest, from the facts narrated in this and my previous letter, that electricity and heat are each distinct and separate elements which cannot be transformed into one another as has been previously supposed to be the case in accordance with the theory of energy as at present promulgated.

James Johnstone.

8, Merchiston Park, Edinburgh,
April 12th, 1886.

P.S.—In the last paragraph of my previous letter there is the question, "What induced the latent electricity to leave the oxygen?" The last word should have been *ozone*, not oxygen.

J. J.

The "Valve" Telephone.

With reference to his letter in your issue for March 12th, perhaps Mr. Sydney F. Walker will be good enough to say wherein lay the difference between the good Valve transmitter which he describes, and the other which was put up by the inspector, and which never spoke properly. Was the latter of the same construction as the former, only with a metallic instead of a carbon ball, or were the two different in form? I ask this question, as, from curiosity, I am anxious to ascertain whether the "New" company are in any way making use of silicium or other bronzes instead of carbon. They have given out that they prefer the former, but seem universally to use the latter. Again, Mr. Walker mentions the fact that in the trial he refers to the whole of the battery was in the main line, which occasioned the continuous ringing of the intermediate bell when the extreme stations were talking. By this are we to understand that receivers, transmitters, and batteries were arranged in simple circuit in series in the way the London and Globe Company used to work their Hunnings's transmitters and "Mechanic" receivers, or were the "plug" arrangement of Prof. Thompson and an induction coil in use?

An answer to the above from Mr. Walker, or from Mr. A. W. Hine, who seems to have had similar experiences, will doubtless interest others besides

"Telephonist."

Professor Hughes on Self-Induction.

On January the 28th, of this year, Professor D. E. Hughes, as the newly-elected president of the Society of Telegraph Engineers and Electricians, read, as his inaugural address, a paper entitled, "The self-induction of an electric current in relation to the nature and form of its conductor."

I regret that I was unable to be present at the reading of the paper, or on any of the evenings that were devoted to the discussion of the same, but, if I understand Professor Hughes's meaning, the object of his paper is to prove that conductors of different metals and of different forms vary in their resistance in accordance with the nature of the electrical conditions under which they are placed. For instance, the resistance of a conductor would be different for a permanent current to what it would be for intermittent currents, the amount of the difference depending on the form of the conductor, *i.e.*, whether solid wire, strand, or ribbon, or a combination of two or more such conductors.

The apparatus for his experiments consisted of a specially constructed induction bridge, in which the galvanometer was replaced by a telephone, and it was found to be impossible, however accurately the wires were balanced for a constant current, to silence the telephone when intermittent currents were passing in the battery circuit. If the galvanometer be used, a perfect balance is obtained both with constant and intermittent currents. In Professor Hughes's arrangement the sound of the telephone can only be reduced to a minimum; consequently, to produce silence he sends through the circuit counter currents produced by electro-dynamic induction, and then again alters the length of the wire in circuit until no sound is heard in the telephone, and the true resistance of the wire is supposed to be thus ascertained. The counter currents are set up by two bobbins of wire, a primary and a secondary one, the primary being in the battery circuit and the secondary in the telephone circuit, so that, by altering the relative positions of the two bobbins, variations in the currents of the telephone circuit can be produced.

Now, some very remarkable results appear to have been obtained with this novel combination of an ordinary Wheatstone bridge and the professor's "induction balance," and, from these results, Professor Hughes lays down the following startling propositions for the guidance of the practical telegraph engineer and electrician:—

"A solid rod of iron is the worst possible form for a lightning conductor."

"The conductor, if of copper, should be of ribbon form, or, if of iron, of numerous stranded wires, or a wide ribbon of similar conductivity to that of the copper."

"That there is a remarkable difference in the resistance of a wire during the 'stable' and the 'variable' period," or, in other words, with the results obtained with a constant current or intermittent currents.

"An iron wire has, with rapid currents, *more than three times* the resistance during its actual work than that supposed to be its true resistance."

"The more rapid the contacts of a telegraphic instrument the greater will be the difference between copper and iron."

"A solid iron wire is unsuitable for telegraph instruments requiring extremely rapid currents."

"Copper would reign supreme if it were not for the fact that stranded iron wires have greater rapidity of action than copper."

Now these propositions, which I have quoted, are so opposed to all my experience that I at once put them to a simple, but, I think, efficient practical test. A circuit was made up of an astatic mirror reflecting galvanometer, a battery of one Grove cell, a rapid interrupter, and a strand copper conductor of about 250 yards in length insulated by suspension in the atmosphere. The interrupter was so constructed that from one hundred to two thousand interruptions of the current could be made per minute.

The internal resistance of the battery was ·2 of an ohm, and the resistance of the galvanometer ·1, whilst the resistance of the conductor was 1·07 ohms, so that the total resistance of the circuit was 1·37 ohms. Under these conditions the deflection of the galvanometer was obtained both with a constant current and with rapidly intermittent currents. The wire under test was then removed, and conductors of different metals and forms substituted for it, each conductor having identically the same resistance as measured by a Wheatstone bridge, and it was found that whatever the nature and form of the conductor, the deflection obtained on the galvanometer was the same, showing that the resistance of a conductor of constant section and material is strictly proportional to the length and inversely proportional to the area of its cross section, or, in other words, inversely proportional to the weight per unit length, and that, whether it is carrying a constant current or intermittent currents. It therefore follows that, having ascertained by well-known laws the resistance necessary to carry a desired current, it matters not, electrically, of what metal or form the conductor is made. Of course, I am referring to aerial wires for telegraphic purposes or for lightning conductors. For the conductors of submarine telegraph

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cables of course these remarks would not apply, but that has nothing to do with the present case. Having satisfied myself in the matter, I took no further notice of it, thinking that the erroneous impressions Professor Hughes had conceived were of such a nature that he would soon discover his mistake and immediately take means to rectify the same. But, now that I find the subject is likely to be re-discussed, I think it well to publish the results of my experiments, which prove, to my mind, that Professor Hughes has been misled in endeavouring to obtain reliable results by a combination of electro-dynamic, electro-dynamic-inductive, and electro-magnetic-inductive currents, without a due regard to the laws which govern the same.

Willoughby Smith.

April 12th, 1886.

[We have commented upon this letter in "Notes."—EDS. ELEC. REV.]

I observe in your last issue that Profs. Ayrton and Perry publish some remarks made by Prof. Ayrton during the discussion on Prof. Hughes's inaugural address, giving a very simple and ingenious proof of the fact that if by reason of self-induction or otherwise the current density is not uniform throughout the cross section of the conductor, the power consumed in producing heat is always greater for the same total current, and that, therefore, the resistance encountered by this current is greater than with a uniform current density.

This is, in fact, quite self-evident, if we consider the conductor as formed of several parallel conductors together equivalent to it, and that in some of these opposing E.M.Fs. prevent the passage of the proper share of current.

I see, however, that Prof. Ayrton mentions an experiment made by me in connection with this subject, and as he has not quite exactly detailed the experiment as actually performed, it may perhaps be desirable to do so.

At the time this experiment was performed, now some years ago, I was engaged in attempting to measure the efficiency (or possibly you would call it *strain*) of the lampe soleil, and also of the Gramme alternating dynamo separately.

In order to check the Siemens dynamometer I constructed the following very simple instrument :—I laid out along a board a flat band of German silver, of ample sectional area to take the largest current I proposed to measure without appreciable heating.

I also took a small brass tube, with a magnifying lens fixed at one end, and a ½-inch length of ·0014-inch iridio-platinum wire fixed between two poles of stout copper wire near the other end, which was closed. The eye piece was enlarged so as to fit closely round the eye, and thus all light was excluded from the tube when applied to the eye.

This arrangement I call my "Veracity Detector."

One lead from this was attached to one end of the German silver band and the other was slid along it, starting from this end until the radiation from the iridio-platinum wire was just visible as a sort of dusky red.

This was first done with continuous currents, measured both by the electro-dynamometer and by other methods, and a scale of currents marked along the German silver band, which were of course inversely as the distances from the end approximately and afterwards with alternating currents. I cannot at the moment lay my hand on the records of these experiments, but remember perfectly that the readings on the electro-dynamometer were low for the alternating currents in every case. I am not quite so certain how the difference was affected by an alteration in speed of alternation, but have got all the apparatus and intend when opportunity serves to investigate the question more completely.

The "Veracity Detector" is so named because one can often "catch out" a youthful and enthusiastic experimentalist straining his eye to catch the first faint dawn of dusky red by slightly lifting the slider from the conductor occasionally when just about the critical point.

This application will be found useful by professors, and is not patented.

P. Cardew.

Chatham, *April 12th*, 1886.

[We should not speak of the *strain* of a sun lamp.—EDS. ELEC. REV.]

Dynamo Testing.

I hasten to thank Dr. E. Hopkinson for his courteous reply to my letter of the 23rd ult., and to assure him that he has correctly apprehended my difficulty. In the present state of our knowledge regarding the action of dynamos and motors there are, however, grave objections to his method of surmounting it, and I therefore venture to again trouble you on the subject, as the method used may perhaps be largely adopted, and more especially as the point raised has a direct bearing on the question, which has been much discussed lately, of the relative efficiences of the same machine worked as a generator and as a motor.

The full problem may be briefly stated as follows :—

Let e and e^1 = the commercial efficiencies of the generator and motor respectively ;
„ V and V^1 = the measured potential differences at terminals of generator and motor ;
„ i = the current flowing in the external circuit ;
„ i_m = the current flowing in the motor field-magnets ;
„ r_m = the resistance of the motor field-magnets ;
„ w = the power supplied by the belt ;
„ W = „ „ „ „ motor to generator ;

Then
$$e = \frac{V(i + i_m)}{W + w} = \frac{A}{W + w}$$
$$e^1 = \frac{W}{V^1 i + i^2_m r_m} = \frac{W}{B}$$
where A and B can be calculated from the electrical measurements.

Whence
$$e = \frac{A}{B e^1 + w}$$
or
$$B e^1 e + w e = A \qquad (1)$$
a *single* equation only to determine the *two* unknown quantities e and e^1.

To surmount the difficulty here indicated, Dr. Hopkinson assumes that the integral loss of converting mechanical into electrical energy, and *vice versâ*, is the same in both armatures. The equation might also be solved by assuming $e = e^1$, which, in the present case, is nearly the same thing. But both these methods beg the whole question referred to above, and the first leads, in some of the published figures, to the curious result that the efficiency of the motor is higher than that of the generator. Also, it is not quite correct to say that the only effect of dividing the loss in any other proportion would be to increase the efficiency of one machine, and diminish that of the other by the *same* percentage. Taking the example selected by Dr. Hopkinson, the constants in equation (1) are A=40013, B=38896, w=6604. If, now, we assume e=95 per cent. (an *increase* of 1·77 per cent.), we find e^1=91·3 per cent. (a *decrease* of 2·07 per cent.), and the efficiency of transmission is slightly diminished. The difference in *this* example is not great, but, as Dr. Hopkinson has himself remarked, where the total loss is so small a slight difference becomes not altogether unimportant. Also, it is easy to see that wherever the efficiencies do not range so high the results, worked out on Dr. Hopkinson's assumption, may be rather wide of the mark, and it is on this account that I have ventured to trouble you again. As the assumption last made (e=95 per cent.) is very nearly the most favourable one possible for the generator, and, consequently, the least favourable for the motor, the figures given show

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very nearly the limits of the relative efficiencies of the two as calculated from this particular test, assuming that the value of *w* is correct, about which there appears to be some slight doubt.

In conclusion, I wish to say that the above is not written in any captious spirit, nor with any wish to detract from the high efficiency which must be conceded to the motor in whatever light the figures are interpreted, an efficiency which is, I believe, by far the highest yet recorded. My only desire has been to point out an error which may possibly arise (and be a serious one) if the method be applied to less efficient machines, and more especially if the machines coupled together are dissimilar.

R. Mullineux Walmsley.

Finsbury Technical College,
April 13th, 1886.

Rapacity of Telephone Companies.

In your issue of April 9th, we noticed a paragraph headed "Mechanical Telephones," signed "Iron," by which it would appear that users of a mechanical telephone have been threatened with proceedings by an agent of one of the electrical telephone companies, unless "Iron" removes the mechanical telephone he is using.

We notice your editorial note at the bottom of the paragraph referred to, and we take this opportunity of stating that this is not the only instance in which electrical telephone companies or their licensees have endeavoured to frighten users of mechanical telephones. In the instance referred to, the United Telephone Company wrote a very strong letter to a certain bank using our instrument, threatening them that unless it were at once removed, they would institute proceedings against them, for an infringement of their (the United Telephone Company's) patent rights. On learning these facts, our solicitors were instructed to at once communicate with the United Telephone Company, which they did, and after a correspondence of some length the United Telephone Company withdrew all suggestion of infringement, and our customer is about having our instrument restored.

We think the above facts will show that the telephone companies, more especially those that are working under the United Telephone Companies' patents, are using their utmost endeavours either by fair or foul means to prevent the legitimate use of rival instruments, even as in the present instance obviously and admittedly no infringement of the patent held by them.

The Mechanical Telephone Company, Limited,
WM. J. BURNSIDE, *Managing Director.*

London, *13th April*, 1886.

[It requires some degree of hardihood to hazard an opinion adverse to the success of the United Telephone Company in any legal action it may enter upon; but we scarcely think even Mr. Justice North would be able to discover the combination of diaphragm and Edisonian tension regulators in the mechanical telephone. A "North" diaphragm there undoubtedly is, but no Edisonian tension regulators which have yet been described in Court or elsewhere. We are not surprised, however, that the owners of the combined patents try to frighten any semblance of opposition out of the field when no other means of destroying it are available.—EDS. ELEC. REV.]

Primary Batteries.

I am endeavouring to elucidate the present condition of electric lighting by means of primary batteries. For this purpose I am collating information concerning them with a view to publishing the result in connection with a book I am engaged on.

At present the subject is clearly in the realms of the unknown, and I should be very glad if those of your readers who are able to furnish any reliable data would kindly communicate with me as under. The testimony of manufacturers as to the excellencies of their batteries is not solicited. I am already acquainted with the value of their superlative hyperboles.

The information I am anxious to obtain is :—

Have any primary batteries been successfully employed for two years? If so, where, and how many lamps?

The same questions as applied to one year's working, or even again for, say, eight months?

What is the largest number of lamps now worked from a primary battery, and for how long has it been in operation?

Again, can any places be named in England where primary batteries have been working over, say, eight 10 C.P. lamps successfully for six or eight months?

By successfully I don't mean economically; we have not come to that yet. The question of cost is in this case only of secondary importance, and I am first desirous of locating any instances of primary batteries giving a steady constant current nightly for any period over six months.

I do not wish to exclude "damaging" information as this is also of importance; and although I fear voluminous accounts could be written on this head, I should be glad to hear of any personal experiences of your readers.

It is only by enquiries such as the above that really reliable facts can be tabulated, and therefore such information will be of value and highly esteemed by

Jno. B. Verity.

Moorcroft, Weybridge,
April 10th, 1886.

[The information obtainable by the means suggested would, we believe, be of the slightest, and, we much fear, for the most part unreliable.—EDS. ELEC. REV.]

Charging Secondary Batteries.

Referring to your note on page 334, I fear that my letter was, in this respect, somewhat inaccurately worded. But if your friend will kindly refer to the tabulated statement which accompanied it, he will observe that a diminution of current *is* recorded towards the end of the afternoon's charging. And any other result would, as it seems to me, be inconsistent with the fundamental equation which controls the mutual relationship of E C and R.

Thomas S. Bazley.

Athenæum Club, Pall Mall,
April 12th, 1886.

"Compound Wound Dynamos in Parallel."

Twelve Crompton-Bürgin compound wound dynamos were connected and working in parallel circuit at the Law Courts in 1883. A plan of the switch board was illustrated in the ELECTRICAL REVIEW, I believe, in December, 1882.

A. Grundy.

April 13th, 1886.

With reference to Mr. E. W. Rice, jun.'s, letter in your last issue, the method of connecting dynamos in parallel, by joining together both similar terminals and similar brushes, is not new, as it was used several years ago with Gramme machines.

Messrs. Sautter, Lemonnier & Co.'s representative thus connected two A Grammes for our trials in 1879, and stated that it was the method they usually adopted. Of course these were series machines, but the difficulty lies in the series winding.

P. Cardew.

Chatham, *April 12th*, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 439.

SECONDARY GENERATORS OR TRANSFORMERS.

WE hope shortly to be able to give some further information respecting the working of the secondary generators in the city of Tours, a description of the plant there employed having already appeared in our pages. The performance of these induction coils in the town above mentioned will be watched with all the more interest inasmuch that, if the information which has reached us is reliable, and this we have no reason to doubt, the Gaulard-Gibbs apparatus do not appear to give satisfaction at the Grosvenor Gallery.

We have never waxed enthusiastic over this current-transforming method of distributing electricity, although we freely admit that Messrs. Gaulard and Gibbs have achieved results which we but little anticipated. We still think, however, that their most favourable records between energy expended and energy returned occurred under conditions which will not be met with in practice. But it is not so much on the point of percentage of return that we desire to say a few words as upon the actual value of the apparatus for general use.

We understand that one of the principal faults to be found in the Grosvenor Gallery apparatus is that of very bad regulation, *i.e.*, if a given number of lamps, say 100, are fairly constant while all are in operation, very bad regulation ensues amongst the remainder if some 20 or 30 are turned out. If this is a fact, cannot something be devised to remedy a drawback so disagreeable and inconvenient to the consumer? Whilst we are now fairly conversant with the good and bad points of secondary batteries and can to a certain extent make provision against their vagaries, we are very much in the dark so far as any working data is concerned which deals with induction coils. Prof. Galileo Ferraris' elaborate report on these apparatus gave but little indication of what might be met with in commercial operations; and, if rumour speaks truly, there are yet many difficulties to be overcome before electrical transformers will be generally adopted.

It appears to us that for lighting over small areas their employment is not advisable, and that their real *forte* is in supplying power over long distances. Even in the latter case secondary batteries can be as readily made subservient to our desires; but induction coils have these advantages—they are doubtless very much cheaper than accumulators, and they are practically indestructible. Naturally the number of persons having any real experience in the working of transformers is exceedingly limited; when such practice becomes more general, the deficiencies now existing will be supplied if scientific opinion decides that there is a future for these apparatus.

SPANISH TELEGRAPHS.

THE Spanish Administration of Posts and Telegraphs has published the telegraph statistics for the half year ending June, 1885. We gather from it that during this period there has been a considerable diminution in the receipts, due it is said to very serious loss of crops, unusually severe storms, and notably to the cholera epidemic.

The following brief *resumé* of the information given in the report may be of interest:—

The peninsula is divided into six telegraph departments, among which are included the Balearic and Canary Islands, and are named, respectively, the Northern, North-Eastern, North-Western, Southern, Eastern, and Western divisions; these are subdivided into 13 telegraph centres.

The telegraph corps consists of 3,540 persons, all told, of whom only 45 are females. The principal officials are—an inspector-general chief of the telegraph department, an inspector-general chief of general service, 6 divisional or departmental inspectors, and 13 chiefs of centres.

During the six months ending June 30th, 1885, there were only 108 kilomètres of line constructed. At this date the Government lines consisted of:

17,596	kilomètres of	overhead lines,
129	„ „	underground cables,
236	„ „	submarine „

carrying the following lengths of conductors:

Overhead lines ...	42,981	kilomètres.
Underground cables	337	„
Submarine „	236	„

These figures do not include private lines, the lines belonging to railway companies authorised by Government to conduct public service, or telephone lines.

The report gives the number and nature of instruments employed on the Government lines as:

Morse	868
Hughes	20
Duplex	8
Translators	82

There is no account given of the instruments employed on lines other than Government, but it is stated that the railway companies chiefly use the Bréguet system.

During the six months referred to, there were 854 occasions on which the lines were interrupted for more than six hours, due to the following causes:—

Breaking of wire	212
Storms	421
Purposely	33
Unknown	188

Although the report gives the receipts, there is no account of the expenditure, so it is impossible to form any idea of the revenue accruing to the Government from its telegraph business.

The telephone system has been rapidly extending, and at the date already mentioned there were, besides 797 stations actually working, some 99 in course of installation. The receipts from the telephone service during the six months ending June 30th, 1885, amount to about £1,161, and the expenditure, which, however, counts from August of 1884, when a large increase of the telephone system was commenced, is given as £11,200. This amount includes, not only material already used, but sufficient for the continuation of the extension of the lines during the next six months.

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PERMANENT COMMUNICATION WITH TRAINS IN MOTION.

RAILWAY accidents occur frequently enough to make it desirable that the question, so difficult, and yet so interesting and important, of permanent communication, telegraphic or telephonic, between trains in motion and the neighbouring stations should be solved. Without insisting on the evident utility of the solution of such a problem, we propose passing in review, writes M. Hospitalier, in *La Nature*, the principles of the devices proposed or tried hitherto, pointing out more particularly those which for about a year have produced some sensation in America, and, by report, in Europe. We shall speak only of permanent communication.

The idea of establishing permanent communication with trains in motion is by no means very recent. The first method proposed consisted in a special continuous rail laid down between two ordinary rails, on which a movable rubber established a permanent contact. A system thus constituted was experimented with for a month on a trial line laid down between Argenteuil and St. Cloud. It had to be given up in practice after a month's service.

A closer study of electric actions at a distance, the discovery of polarised relays, of electric diapasons, and lastly, that of the telephone have considerably augmented the resources of the electrical engineer. Several inventors have sought if it was not possible to utilise these novel discoveries by suppressing the permanent metallic communication and substituting for it inductive actions which are transmitted with great rapidity through all dielectrics, especially the air. This is the principle which characterises the new systems, already very numerous, and which may be divided into two great classes :—

1. Magnetic induction systems.
2. Electrostatic induction systems.

Each of these classes admits of sub-divisions founded on the nature of the transmitting and receiving apparatus, which in different cases are telegraphic relays, telephones, or a combination of both.

Magnetic Induction Systems.—The first apparatus for telegraphic communication with moving trains, based upon the principle of magnetic induction, was devised by Mr. L. J. Phelps, and established more than a year ago, by way of experiment, on a line of about 22 kilometres in length, at New York, between Haarlem River and New Rochelle junction. It has been in daily regular use ever since, and has recently prevented an accident by informing the conductor of a moving train that a preceding train had just broken its couplings, and that several of the carriages from the tail of this train were obstructing the line. The following is the principle of the Phelps system :—

A fixed conductor is placed in the middle of the space between the two rails ; it is insulated in a sheath of wood ; it communicates with the earth by one of its extremities, and with the manipulator of the station by its other end.

The manipulator allows a succession of long and short currents to pass along this wire, which currents act upon the movable induced circuit carried by the train.

This movable induced circuit is constituted by an elongated vertical bobbin with 90 folds, occupying the whole length of the telegraphic van and being about 2,400 metres in length, of which 1,000 metres are brought very near the conductor placed between the rails, and another 1,000 metres are as far removed from it as possible.

The free ends terminate in a telegraphic station installed in the van. Two cases are possible, according as the van receives or transmits messages.

For reception, the induced bobbin is connected to a very sensitive relay which closes the circuit of a local battery upon a sounder. For transmission, the battery is closed upon the induced bobbin by the intermediation of a buzzer, which sends a series of interrupted currents into the bobbin. These currents induce in the line a series of currents which affect a telephone at the receiving station, and enable Morse sound signals to be read. Mr. Phelps, considering that the telephone could not be employed as a recipient on the train on account of the noise, makes use of a relay and a sounder which produces clicks perceptible at 3 metres from the apparatus, even when the train is going at full speed.

The construction of the relay was very delicate, for it had to obey very feeble induced currents, and yet remain insensible to the shocks, vibrations, and other movements of the train, which are often very violent. This result was obtained by giving the armature a very slight mass, a very small momentum of inertia, and causing this armature to move in a very intense magnetic field, constituted by two powerful permanent magnets.

Hitherto, only permanent communications have been effected between a moving train and a station ; we conceive that it will be possible to establish a communication between two moving trains ; but, from a practical point of view, the question presents less interest, since the utility of communication exists especially between the train and the station from which it has been despatched, on which it is dependent until it enters another section.

Mr. Phelps had even foreseen the case of a station completely isolated placed in communication with the line by induction, by arranging a fixed induced coil of a suitable length parallel to the principal conductor. Such are the principles applied in the Phelps system.

Electrostatic Induction Systems.—Some years ago, about 1881, Mr. W. W. Smith thought that it would be possible to establish a permanent communication with moving trains by means of electrostatic actions, and he even took out a patent in this direction without carrying the matter further, until Messrs. Gilliland and Edison seized upon it, developed it, and rendered its application possible.

The principle consists in forming a vast condenser, of which one of the plates (fixed) is constituted by the telegraphic wires running along the line ; the other plate (movable) is formed by the metal roofs of the carriages, suitably insulated and connected with each other electrically, the dielectric being nothing other than the stratum of air comprised between the wires of the telegraph and the covers of the carriages. Whenever the potential of the telegraphic wires or that of the carriage covers is raised, this condenser with a movable plate is charged, and the charge of this condenser will produce a momentary current of charge which may be used to set a suitable receiver in action. In order to have sensible charges, capable of actuating receivers (since the capacity of the condenser is low), high potentials of charge must be employed, which may be effected by means of transformers.

The telegrams arrive at the stations in the form of Morse signals, received in two telephones, which the official posted in the train keeps to his ears in a permanent manner (fig. 1) by means of a head-band, which leaves his hands at liberty.

The combinations being very numerous, we shall content ourselves with indicating one of those which is most readily explained. Fig. 2 shows the arrangements of one of these stations, and fig. 3 that of the moving post in the train.

We see in fig. 3 that the post comprises four distinct circuits : 1, the circuit of a buzzer, worked by a special battery, P, and making about 500 electric contacts per second. This buzzer works continuously during the whole time of the transmission. 2. The circuit of a battery, P′, communicating with the thick wire inductor circuit of a transformer or induction bobbin, B, a bobbin into which are sent currents interrupted each time that the manipulator, M, is pressed. 3. The induced circuit of the bobbin, B, which in the position of transmission communicates by one extremity with the earth through the medium of the wheels of the carriage and of the rails, and by the other extremity with the insulated roof of the carriages by the medium

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of the commutator, S. In the position of reception the induced circuit is open at S. 4. The circuit of the telephone, T, is connected to the earth by one end, whilst the other communicates with the roof of the carriages in the position of reception.

By pressing upon the key we induce, by the medium of the bobbin, B, a rapid series of currents of high tension, which communicate themselves to the line, or to the net of parallel lines, in the form of successive charges and discharges.

is driven into the line itself, whilst the other circuit is closed locally, either on the telephone in the position of reception or on the manipulator, and the buzzer in the position of transmission. This is the arrangement shown in fig. 4; the action is easily understood after what has been said concerning the other combinations.

As a matter of course, in all these applications the ordinary telegraphic wires are utilised without interfering with their own service. It is useful to apply to them the anti-inductive or graduative arrangements

Fig. 1.

Telephonic communications with trains in motion, Edison's system. Official provided with a telephonic apparatus receiving a dispatch in a moving carriage.

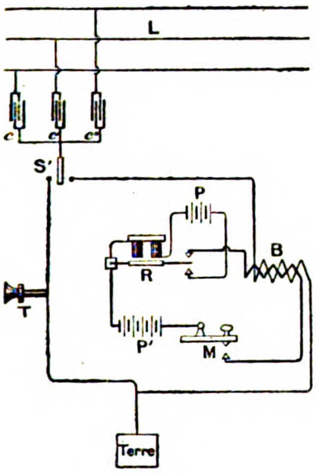

Fig. 2.

Post at the station with condensers.

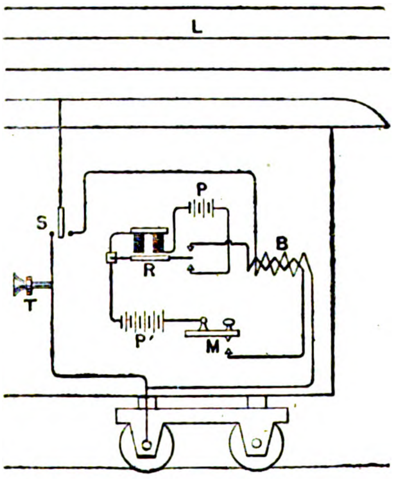

Fig. 3.

Post in the moving train.

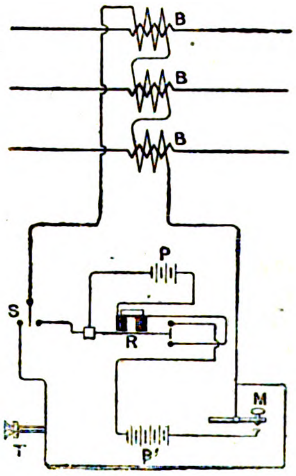

Fig. 4.

Post at the station with transformers.

Fig. 2 shows how these charges of the system of lines can, in turn, charge the condensers, *c*, *c'*, *c''*, and finally influence the recipient telephone, causing it to return a true series of long or short sounds, according to the time during which the key of the manipulator, M, is pressed. The two posts are, moreover, absolutely symmetrical and independent, permitting at will reception or transmission at any post whatever.

We may also in the fixed station substitute for the condensers induction coils, one of the circuits of which

of M. van Rysselberghe, so that the ordinary telegraphic transmissions may not be perceived by the telephone.

Mr. Phelps, whose magneto-inductive system we have just described, has also patented new arrangements founded upon electrostatic actions. In one of these the buzzer or vibrator is suppressed as well as the induction coil, and the sounds are reduced to characteristic clicks at closing and breaking the circuit. Lastly, by substituting a microphone for the Morse

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key, Mr. Phelps proposes to telephone to and from moving trains; but this is merely a project which has not yet received the sanction of experience.

The problem of a permanent telegraphic communication with moving trains may at present, therefore, be considered as solved. But does this mean that it is likely to receive an extended practical application? So far, we do not think so. It must not, in fact, be forgotten that the system immobilises one or more lines for a single communication, and that to effect several at once on the same conductors in different sections, it would be necessary to insulate these sections telephonically, to separate the messages on arrival, and, in a word, realise simultaneous musical telephonic transmissions.

If we may believe the American journals, these phenomena of charges and discharges have led Edison to a real discovery relative to the manner of the propagation of electric charges through the air.

According to him, the air is a conductor for an extremely brief fraction of time; but after this very short instant it is polarised by the passage of the current; its resistance is increased and it ceases to conduct.

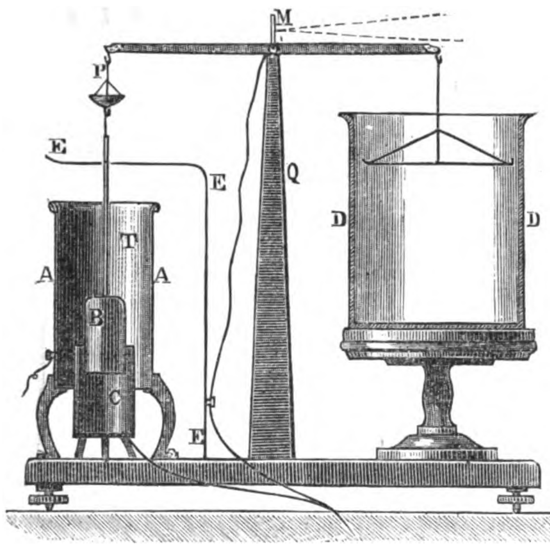
We admit that we do not understand this theory, the bearings of which escape us, but the experiments themselves are of great interest. We shall follow their development and record their progress with the care which they deserve.

AN ABSOLUTE ELECTROMETER GIVING CONTINUOUS INDICATIONS.

By MM. E. BICHAT and R. BLONDLOT.

We have constructed an electrometer founded upon the attraction of two concentric cylinders, and which enables us to measure potentials in absolute values. This electrometer has the double advantage of being easily constructed and of giving continuous indications.

An insulated cylinder, A, A, is connected to the source of the current whose potential is to be measured. A cylinder, B, the axis of which coincides with that of the former, is suspended by the rod, T, to the scale, P,



of a balance, and communicates with the ground by means of the beam of this balance. The cylinder, B, B, plunges in part into a cylindrical vessel, C, rather larger in diameter and communicating likewise with the ground.

A screen, E, E, E, connected with the ground, allows the rod, T, to pass through an aperture; it serves to protect the balance against the attractions of the cylinder, A, A.

The cylinder, A, exerts upon the cylinder, B, a force directed from below upwards, which may be valued by following a procedure analogous to that employed by Maxwell for establishing the theory of Sir W. Thomson's quadrant electrometer. The totality of the cylinders, B and A, forms a condenser; the length of these cylinders being sufficiently great in proportion to their diameters at the mean part of the cylinder, B, and at the corresponding part of A, the distribution is the same as if they were infinitely long, that is, in this region the equipotential surfaces are concentric cylinders and the lines of force are the radii; above and below the distribution is different. If we suppose that the cylinder, B, projects out of C, by a quantity which is not too great, we may consider the change in distribution as having consisted in a simple prolongation of the portion in which the distribution is the same as if the cylinders were indefinite, the portion situate above, where the distribution is irregular, being simply displaced.

Let R and r be the respective radii of the cylinders A and B; V the potential of A, that of B being zero; let, further, F be the force which attracts the cylinder, B, from below upwards. Let us suppose that the cylinder, B, is raised by a quantity, dz, the work of the electric forces is then $F\,dz$. According to the theorem relative to the displacement of bodies of a constant potential this work is equal to the increase of energy of the system. But the increase of charge is the product of V by the capacity of a portion of an indefinite cylindrical condenser of the height, dz; it is therefore equal to

$$\frac{1}{2}\frac{V\,dz}{L\frac{R}{r}}.$$

In consequence the increase of energy is

$$\frac{1}{4}\frac{V^2\,dz}{L\frac{R}{r}}$$

and we have the equation

$$F\,dz = \frac{V^2\,dz}{4\,L\frac{R}{r}}.$$

Whence

$$V^2 = 4\,F\,.\,L\frac{R}{r}.$$

If we measure R and r in centimetres and F in dynes we shall have V^2 in absolute units of the C. G. S. system.

To measure F we put marked weights upon the scale, P, of the balance, until the equilibrium is re-established.

The value of these weights expressed in grammes, multiplied by the number g gives the force expressed in dynes.

In order to annul the oscillations of the beam we suspend in the place of the second scale of the balance a large pasteboard disc which rises and falls in a glass cylinder, D, D, of a rather larger diameter. The friction of the air renders the apparatus almost aperiodic.

The force, F, being, within wide limits, independent of the position of the cylinder, B, it results that we may also make use of this instrument without employing weights, by merely observing the inclination of the beam. A mirror, M, fixed above the knife edge enables us to measure this inclination by the process of reflection. When the equilibrium is established, F is equal to a constant multiplied by the tangent of the angle of inclination. This constant is determined, once for all, by putting in the scale, P, a known weight, the electrometer being discharged, and observing the corresponding deviation.

For small deviations the force, F, is proportional to the number of divisions which have passed before the cross wires of the telescope. A counterpoise, Q, movable along a needle fixed perpendicular to the beam enables the sensitiveness of the balance to be modified at will.

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A calculation based upon the formula given by M. Blavier for the capacity of a condenser formed of two cylinders whose axes do not coincide, but are parallel, shows that a lateral displacement of the cylinder, B, even of two or three millimetres, has only an exceedingly small influence upon the value of the force, F. This is because F is at a minimum when the two cylinders are concentric. In our apparatus, where $R = 5·875$ centimetres and $r = 2·5$ centimetres, F varies only by 0·003 of its value for a deviation of the axes of three millimetres.

In the calculation made above for determining F, the rod T, supporting the cylinder B, has not been taken into account. The complete expression for F is obtained by deducting from the action upon B that which is exerted upon the rod. If we call ρ the radius of the latter, the factor by which we must multiply, the force to obtain the square of the potential is

$$4\left(L\frac{R}{r} - L\frac{R}{\rho}\right).$$

As a verification of the exactness of the indications of our apparatus we have determined the potentials corresponding to a certain number of explosive distances between two spheres; the numbers obtained agree perfectly with those determined with great precision by M. Baille.—*Comptes Rendus.*

ON A CONVENIENT METHOD OF FINDING THE CURRENT IN ANY EXTERNAL CIRCUIT DUE TO TWO OR MORE SOURCES OF E.M.F. IN ARC.

By E. C. RIMINGTON.

POLLARD'S theorem of a shunted battery is well known; it may be enunciated thus :—

When a battery of E.M.F., E, and internal resistance, ρ, is shunted with a shunt, S, it is equivalent to a new battery of E.M.F. $\frac{E\,S}{\rho + S}$ and internal resistance $\frac{\rho\,S}{\rho + S}$.

This theorem holds good whatever be the value of the external resistance, and also if it contain a source of E.M.F. Let us consider this latter case.

Let R be the external resistance and e the E.M.F. acting in it; let the latter be reckoned a positive quantity if it sends, or tends to send, a current in the external circuit in the same direction as the battery, E, and a negative quantity if in the opposite direction.

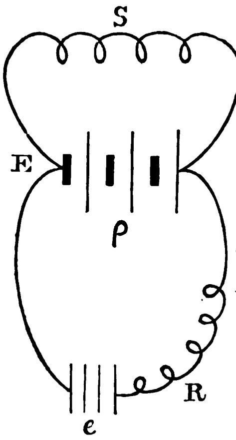

FIG. 1.

Let us suppose the shunted battery to be replaced by a new battery of E.M.F., E_1, and internal resistance, ρ_1, which gives the same current in the external circuit as the shunted battery.

Then if C be the current in the external circuit in the two cases,

$$C = \frac{E_1 + e}{\rho_1 + R}$$

in fig. 2.

By applying Kirchoff's laws to fig. 1 and solving for C, we obtain

$$C = \frac{E\,S + e\,(\rho + S)}{\rho\,S + \rho\,R + R\,S}.$$

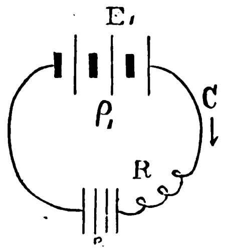

FIG. 2.

Dividing numerator and denominator of this by $\rho + S$ we have

$$C = \frac{\frac{E\,S}{\rho + S} + e}{\frac{\rho\,S}{\rho + S} + R} = \frac{E_1 + e}{\rho_1 + R}.$$

Now the only variables are e and R.

Therefore $E_1 = \frac{E\,S}{\rho + S}$ and $\rho_1 = \frac{\rho\,S}{\rho + S}$.

The principle of Pollard's theorem may be applied to the case of two dissimilar cells or batteries in arc in the following manner :—

Let E_1 and E_2 be the E.M.Fs. of the two batteries, and let them be quantities of the same sign if they send, or tend to send, currents through the external circuit in the same direction, and of opposite signs if in opposite directions. Let ρ_1 and ρ_2 be the internal resistances of the batteries and let R be the external resistance, which may have any value. Let C be the current in the external circuit. Then, by means of Kirchoff's laws, we obtain from fig. 3

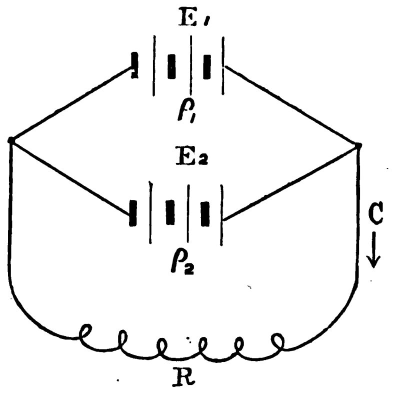

FIG. 3.

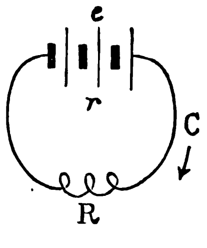

FIG. 4.

$$C = \frac{E_1\,\rho_2 + E_2\,\rho_1}{\rho_1\,\rho_2 + R\,\rho_1 + R\,\rho_2} = \frac{E_1\,\rho_2 + E_2\,\rho_1}{\rho_1\,\rho_2 + R\,(\rho_1 + \rho_2)}.$$

Dividing numerator and denominator by $\rho_1 + \rho_2$ we have

$$C = \frac{\frac{E_1\,\rho_2 + E_2\,\rho_1}{\rho_1 + \rho_2}}{\frac{\rho_1\,\rho_2}{\rho_1 + \rho_2} + R}$$

Let e be the E.M.F. and r the internal resistance of another battery which sends the same current, C, through the same external resistance. Then from fig. 4

$$C = \frac{e}{r + R}.$$

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Therefore

$$\frac{e}{r + R} = \frac{\dfrac{E_1\rho_2 + E_2\rho_1}{\rho_1 + \rho_2}}{\dfrac{\rho_1\rho_2}{\rho_1 + \rho_2} + R}$$

Now since R is the only variable

$$e = \frac{E_1\rho_2 + E_2\rho_1}{\rho_1 + \rho_2} \text{ and } r = \frac{\rho_1\rho_2}{\rho_1 + \rho_2}.$$

This result may be enunciated in the following manner:—

If there are two batteries in arc they are equivalent, as regards the external resistance, to a new battery whose E.M.F. equals the E.M.F. of one of them multiplied by the internal resistance of the other plus the E.M.F. of the latter multiplied by the internal resistance of the former, the sum being divided by the sum of their internal resistances; and whose internal resistance is the joint resistance of the two batteries.

This theorem will, like Pollard's, hold when there is an E.M.F. acting in the external circuit.

As an example of the application of this theorem we may take the case of Lumsden's method of comparing two E.M.Fs.

E_1 and E_2 are the two E.M.Fs. to be compared; R_1 and R_2 the total resistances of the branches in which they act; these we can regard as being the internal resistances of the batteries. G is a galvanometer. The test is made by adjusting the resistances, R_1 and R_2,

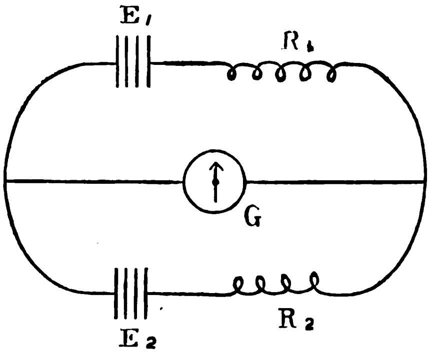

FIG. 5.

until there is no current passing through G. Regard G as the external circuit. Then current through G (fig. 5)

$$= \frac{\dfrac{E_1 R_2 + E_2 R_1}{R_1 + R_2}}{\dfrac{R_1 R_2}{R_1 + R_2} + G} = 0.$$

G is infinite or $E_1 R_2 + E_2 R_1 = 0$.

$$\therefore \frac{E_1}{E_2} = -\frac{R_1}{R_2}.$$

That is to say the E.M.Fs. must be of opposite signs as regards G, and be to one another as the resistances of the branches in which they act. As another example, suppose we have a three-branch circuit, the resistance of each of the branches being R_1, R_2, and R_3, and containing E.M.Fs. of values E_1, E_2, and E_3 respectively, the currents in each of the branches being C_1, C_2, and C_3 respectively.

We require to find the current in any one of the branches, *e.g.* C_1; treat the branch, R_1, in which we wish to find the current as the external circuit. Let the E.M.Fs. be reckoned positive quantities if they tend to send a current through R_1 in one direction (say from left to right) and as negative quantities if in the reverse direction.

Then

$$C_1 = \frac{\dfrac{E_2 R_3 + E_3 R_2}{R_2 + R_3} + E_1}{\dfrac{R_2 R_3}{R_2 + R_3} + R_1} = \frac{E_1 (R_2 + R_3) + E_2 R_3 + E_3 R_2}{R_1 R_2 + R_1 R_3 + R_2 R_3}$$

In the same way by treating $R_2 + R_3$ as the external resistances we can find C_2 and C_3.

If one of the batteries is of very low internal resistance compared to the other, the joint E.M.F. will be very nearly equal to that of the battery having the low internal resistance: since

$$\frac{E_1\rho_2 + E_2\rho_1}{\rho_1 + \rho_2} = \frac{E_1\rho_2}{\rho_2} = E_1, \text{ if } \rho_1 \text{ equals zero,}$$

and if ρ_1 be very small compared to ρ_2 it can easily be seen that it will be very near this value. Also the terminal E.M.F. of the equivalent battery, or

$$E_t = \frac{E_1\rho_2 + E_2\rho_1}{\rho_1 + \rho_2} \times \frac{R}{\dfrac{\rho_1\rho_2}{\rho_1 + \rho_2} + R} = \frac{(E_1\rho_2 + E_2\rho_1) R}{\rho_1\rho_2 + R(\rho_1 + \rho_2)}$$

If ρ_1 is negligible compared to ρ_2 and also to R this becomes equal to E_1 practically.

An example of this is when secondary batteries are employed as regulators for incandescent lighting: the batteries, the dynamo (a shunt one), and the lamps being all put in arc. Here E_1 and ρ_1 represent the E.M.F. and internal resistance of the secondary batteries, and if their internal resistance be small compared to ρ_2 the resistance of the dynamo armature and R the external resistance which is the joint resistance of the lamp circuit and the shunt coils of the dynamo field-magnets, the terminal E.M.F. will remain practically constant even though considerable fluctuations take place in the value of the E.M.F. of the dynamo or E_2 owing to unsteady driving.

Let us suppose the initial E.M.F. of the dynamo or $E_2 = 101$ volts at the correct speed, its armature resistance is $\cdot01^{\omega}$; the internal resistance of the secondary battery is $\cdot001^{\omega}$ and its E.M.F. 100 volts; the external resistance is 1^{ω} and the required terminal E.M.F. is 100 volts, then when the dynamo is being driven at the proper speed no current is passing through the secondary batteries.

Now suppose the speed of the dynamo changes so that its E.M.F. becomes 105 volts, then we have

$$E_1 = 100,\ E_2 = 105,\ \rho_1 = \cdot001,\ \rho_2 = \cdot01,\ R = 1$$

$$\therefore E_t = \frac{100 \times \cdot01 + 105 \times \cdot001}{\cdot01 \times \cdot001 + 1 \times (\cdot01 + \cdot001)} = \frac{1 + \cdot105}{\cdot00001 + \cdot011}$$

$$= 100\cdot36.$$

So that an increase of 5 volts in the E.M.F. of the dynamo only produces an increase of ·36 volt in the terminal E.M.F.

Again, suppose the speed falls so that E_2 becomes 95 volts, then:

$$E_t = \frac{100 \times \cdot01 + 95 \times \cdot001}{\cdot01101} = \frac{1\cdot095}{\cdot01101} = 99\cdot45 \text{ volts.}$$

So that in this case a fall of 6 volts in E_2 only produces a fall of ·55 volt in E_t.

If we wish to find what values we must make the internal resistance and E.M.F. of the secondary battery so that a given alteration in E_2 may produce a given alteration in E_t we can proceed thus. We have

$$E_t = \frac{(E_1\rho_2 + E_2\rho_1) R}{\rho_1(\rho_2 + R) + \rho_2 R}$$

transposing

$$E_1 = \frac{E_t\{\rho_1(\rho_2 + R) + \rho_2 R\} - E_2 R \rho_1}{R\rho_2}.$$

Let E_2 become $E_2 + e$ * and let the terminal E.M.F. become $E_t + e_t$ where e_t is the greatest alteration we wish to have in the terminal E.M.F. from its normal value E_t, e being the greatest alteration in E_2.

Then

$$E_1 = \frac{(E_t + e_t)\{\rho_1(\rho_2 + R) + \rho_2 R\} - (E_2 + e) R \rho_1}{R\rho^2}$$

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$$\therefore (E_t + e_t)\{\rho_1(P_2 + R) + \rho_2 R\} - (E_2 + e) R \rho_1 =$$

$$E_t \{\rho_1(\rho_2 + R) + \rho_2 R\} - E_2 R \rho_1$$

$$\rho_1 \{e_t(\rho_2 + R) - e R\} = - e_t R \rho_2$$

$$\therefore \rho_1 = \frac{e_t R \rho_2}{e R - e_t(\rho_2 + R)}.$$

Having found the value of ρ_1 we can substitute it in the equation

$$E_1 = \frac{E_t \{\rho_1(\rho_2 + R) + \rho_2 R\} - E_2 R \rho_1}{R \rho_2}.$$

and from this determine E_1

To take a numerical example, suppose the normal E.M.F. of the dynamo is 101 volts, its armature resistance $\cdot01^{\omega}$. External resistance is 1^{ω} and terminal E.M.F. required is 100 volts, the greatest variation in which is to be 1 volt; the greatest variation in the E.M.F. of the dynamo being 5 volts.

Here $e = 5,\ e_t = 1$.

$$\therefore \rho_1 = \frac{1 \times 1 \times \cdot01}{5 \times 1 - 1 \times (\cdot01 + 1)} = \frac{\cdot01}{5 - 1\cdot01} = \frac{1}{399} = \cdot0025^{\omega}$$

And

$$E_1 = \frac{100\,(\cdot0025 \times 1\cdot01 + \cdot01) - 101 \times 1 \times \cdot0025}{1 \times \cdot01}$$

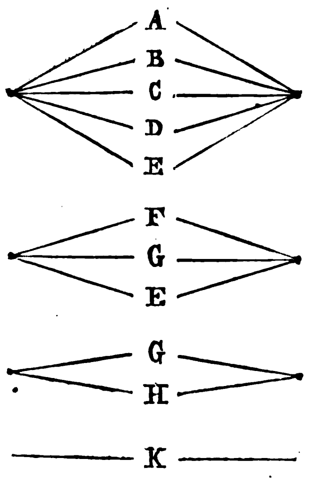
$$= \frac{1\cdot2525 - \cdot2525}{\cdot01} = 100 \text{ volts.}$$

If there are more than two batteries in arc they can be taken in pairs, finding the E.M.F. and internal resistance of the equivalent battery for each pair; again taking the equivalent batteries in pairs, and so on until at last they are reduced to one battery which will be the equivalent of them all.

For instance, suppose batteries A, B, C, D and E, are in arc. Find the equivalent battery to the two, A and B, let it be F. In the same manner let the equivalent battery to C and D be G.

Now find the equivalent to F and E and let it be H.

Find the equivalent of G and H and let it be K. Then K is the battery equivalent to the batteries A, B, C, D and E in arc.



* It will be seen that e and e_t may be either positive or negative quantities but must always have the same sign.

ELECTRIC REPEATERS FOR RAILWAY SIGNALS.

REPEATING railway signals mechanically is almost as old as the "signals" themselves; but as difficulty was experienced owing to the distance, electric repeaters were introduced, but were used for those signals only that were out of sight of the signalman, so that for a long period few of these repeaters were brought into use. The late Mr. C. F. Varley once said that it should be looked upon as a golden rule never to do anything electrically unless distance prevented its being done mechanically. This rule has been largely broken through, as repeaters are in many cases used where the signal is only a few yards distant from the signalman, and in some large railway companies, electric signal repeaters are numbered by the thousand. It is not to be wondered at that there should be a variety of ways of repeating signals. Mr. Warwick, the late telegraph superintendent to the Midland Railway, was one of the first in the field; his scheme indicated signal "on" by current and "off" by gravity; other inventors did the reverse of this; which latter course was not on the side of safety, for, in the event of a wire breaking, the repeater would show "on," although the outdoor signal might be "off;" With the former method, however, any electrical failure would show signal "off," although it might be "on," and the worst that could happen would be the unnecessary stopping of a train. It is needless to say that great improvements have been patented for repeating signals, but most of them have been by, either additional wires or additional batteries, or both; and so show signal "on" and signal "off" by current.

Repeating the "arm" is not the only thing that some of the first inventors did, but they also arranged to indicate whether the signal light was "in" or "out."

Most of these schemes that have been from time to time introduced have necessitated :—

Separate wire for "on" } or one wire and separate bat-
" " "off" } teries for "on" and for "off."
" " "in," "out" being indicated by gravity.

The most complete scheme that has come under our notice is the subject of our illustrations, and is the invention of Mr. J. W. Fletcher, chief telegraph superintendent and engineer of the London and North-Western Railway.

By the use of one wire and one battery, he shows signal "on," "signal "off," signal "wrong," and, by the same wire, and bringing into play automatically two additional cells, shows, light "in," light "out."

Some inventors urge that there is an advantage in using a separate battery for "on," and another for "off," inasmuch that, while one battery is at work, the other is at rest, and so recruiting itself; the inventor of the one battery scheme meets this by saying, that it is not a matter of opinion, but a matter of fact, that decidedly one battery is best, and for the simple reason that, where one battery is used, a fault cannot be remedied except by a new or refreshed battery; where two batteries are used the "on" or the "off" battery only may fail, and the signalman begins to regulate his signal wire, not knowing that it is a battery failure; but when one battery is used, and his repeater shows "wrong," no regulation of the signal wire will move the indicator from the "wrong" position, and the signalman knows that it is an electrical and not a mechanical defect.

Figs. 1, 2, 3, 4 represent the repeater in the signal-box, the contact-box or pole changer, the expansion tube, and the battery at the signal-post, respectively. In fig. 1, E is the repeater arm indicating the position of the signal arm, F a disc working in connection with the arm E, showing when the signal is wrong, D a disc showing when the light is "in" or "out." In fig. 2, the outer springs form the earth connection marked H, the two inner are the battery springs, and the stud at the top will be seen to be the line connection, the lever Z places either the positive pole to "earth," and the

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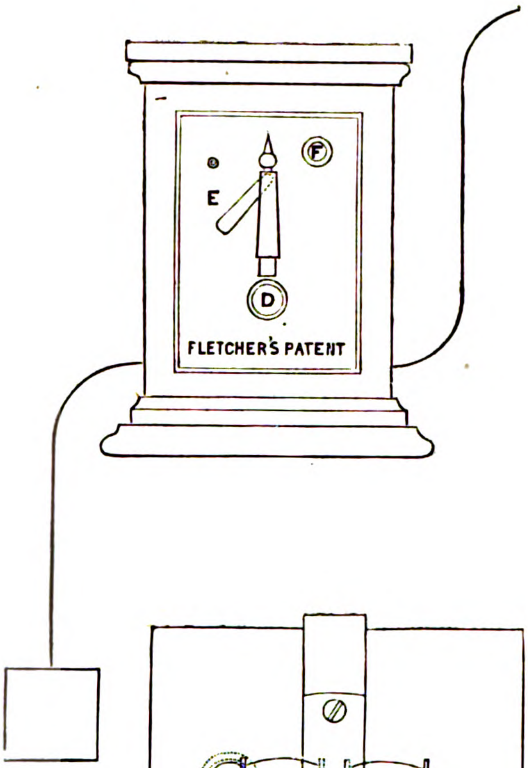
negative to "line," or *vice versâ*. The position shown is that in which the springs are all disconnected, and the arm E shows signal "wrong." In fig. 3, the piece A is moved by the expansion in tube T and has small insulating pieces at each end, on which either the spring S² or S¹ rest, the current passes by means of the springs S¹ or S², through the piece A, to the spring S³ and S⁴, and thence to the contact box, in the normal position of A; that is to say, light "out," the current passes by means of S¹ through A and S³ and S⁴ to the contact box; thus it will be seen that only half the battery is used to repeat the position of the arm, S² resting on the insulating piece; when the light is "in," A is moved by the expansion of T, and the spring S¹ passes on to the insulating piece immediately after S² comes on the metal part of A, thus placing the whole battery in circuit and indicating light "in."

Fig. 5 represents the "repeater," in which the coils, A, actuate the arm, E, and disc, F, and coil, B, the armature, C, and its attachment, C¹, which in turn raise the disc, D. It will be seen that the coils B are joined, one on each side of the coils, A, A.



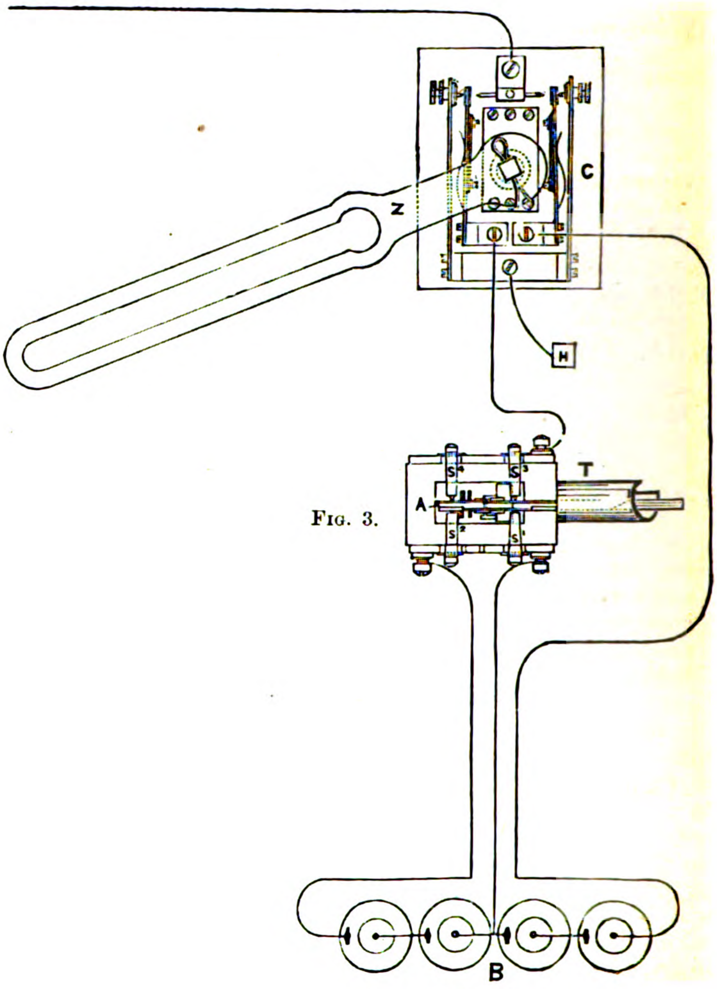


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

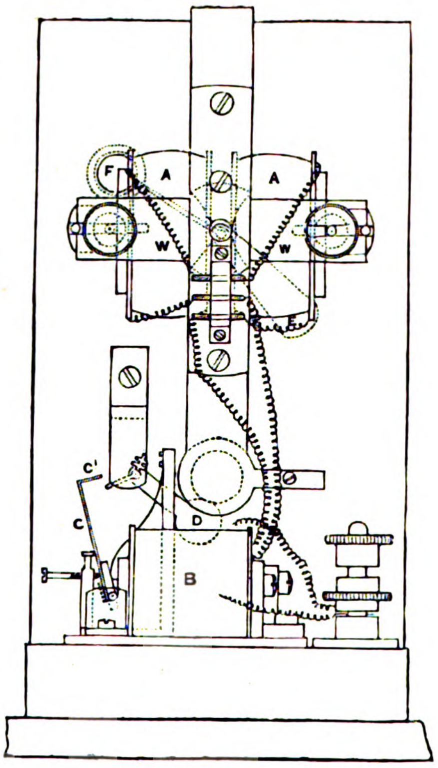


Fig. 5.

THE EFFECT OF AN ELECTRIC CURRENT ON THE OSCILLATIONS OF SUSPENDED BODIES.*

By N. KOLKIN.

SEVERAL years ago I noticed some peculiarities in the oscillations of suspended bodies. If an oscillation was produced in any direction, from any cause, I frequently found that there was a gradual change in direction, until one was reached which was kept with great tenacity. Sometimes there would be changes from oscillation to circulation, and *vice versa*, several times.

These peculiarities have been accounted for in an off-hand way; the causes assigned have been peculiarity of the original impetus given, obstacles on one side of the support, and currents and vortices of air. We may remove these causes, and still we find the same peculiarities.

For experiment, a hole may be bored in the lower side of any horizontal strip of wood that is raised a distance above the ground. A wooden plug, to be inserted in the hole, may be split in two, and the cord or fibre, which carries the suspended body, may be held tightly between the two halves of the plug.

If this pendulum is suspended between two vertical metal plates, respectively of zinc and copper, which are moistened with sulphuric acid, it will always oscillate in the direction of the electric current that passes, through the air, from the zinc to the copper. If the oscillation is at angle with the current, the direction slowly changes. The pendulum should be entirely within the current to be observed.

Electric currents in the atmosphere are indicated in

* Presented to the National Academy of Sciences, Minneapolis, America.

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the same way. These generally have the same direction as the wind, commencing and ceasing an hour or so before it. It depends on the length of the pendulum, whether general or local currents are indicated. The Foucault pendulum indicates electric currents and will not always turn the same way. The pendulum is carried farther in that direction in which the current moves.

In no case do we find that an electric current will originate oscillations of a suspended body, but simply change them. It will also magnify the effect of an impetus given to them, when the two forces act in the same direction; for a suspended body will oscillate more easily in the direction of an electric current than in any other.

By means of minute pendulums it is possible to detect the smallest current, and they are the only means by which many mysteries in nature can be investigated. They have been used by the author for several years, both to test the accuracy of their indications and in physical research. The method, however, is very tedious.

When a pendulum is oscillated in damp, foggy, or very cold weather, the oscillations will never change from the original direction. In such states of the atmosphere the pendulum will also come to rest sooner. The air may also be given the same condition by the friction of bodies, but the friction of bodies of opposite character, as wood and metal, neutralises their effect. For such reasons crowds of persons, or only one person, may easily spoil experiments of this kind. It is only in fair weather that these experiments can be carried on undisturbed.

If electricity is an ethereal fluid, that which gives the air the peculiarity spoken of, seems to be an ethereal substance of another consistency; for the power to hold the pendulum may be imparted to the air, over a well-defined region, by the friction of substances, and an electric current will pass through it, as it can be detected where it enters and where it emerges from it.

THE STRANGE HISTORY OF A DYNAMO,

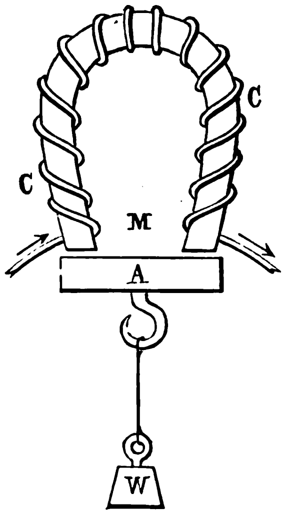
As told by itself to

A. DYNAMICABLE.

[*All rights reserved.*]

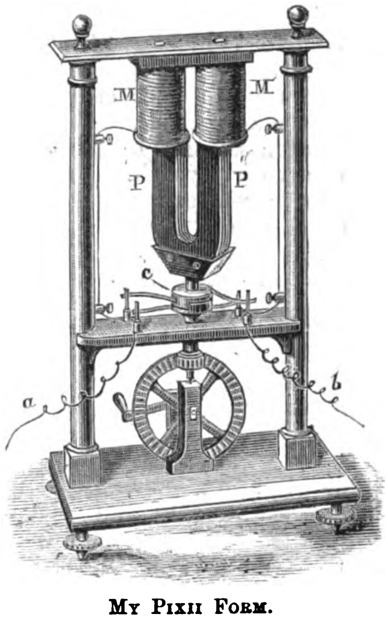
(*Continued from page* 349.)

ONE Pixii is held responsible for my first appearance in the world in such a form as to yield in my turn that which led to my being, viz., an electric current. Tiny, weak, and undeveloped as I then seemed, I was the object of great wonderment, and much curiosity was evinced as to what the future had in store for me. Although I have to carry my memory back to the year 1832, you may rest assured that the portrait which I present to you gives a faithful representation of my poor little self as I then appeared. I cannot now repress a smile at the ridiculous figure I cut, although I was mightily proud and self-satisfied in those days. Time, however, changes all things and nothing more, to my way of thinking, than dynamos. But I must get on with my narrative. You, of course, have not forgotten Arago's discovery, from which we found that a galvanic current passing through a coil of wire surrounding a rod of iron transforms the latter into a powerful magnet, or more precisely speaking, into an *electro-magnet*,—or that a magnet proper, or so-called *permanent* magnet, is a rod or bar of *steel* of any form which has been magnetised and which then *retains* (soft iron does not) its magnetism. Towards the end of the year 1825 one of your countrymen, Sturgeon by name, made a considerable advance on Arago's experiment by making an electro-magnet in a horseshoe form. The improvement does not, on the face of it, look as if much thought had been expended thereon, for it is simply, as you observe, the straight rod of Arago bent into a horseshoe form so as to bring its ends into proximity one with the other. The importance of this arrangement can, however, be scarcely over-rated, for by making use of both ends of the electro-magnet a weight many times heavier may be carried than is possible when one end only is employed. In this sketch, M is the bent iron rod upon



STURGEON'S ELECTRO-MAGNET.

which is wound, in the same direction throughout, the insulated wire, C, through which a strong galvanic current is flowing, say, in the direction of the arrows. Under these conditions the iron rod becomes powerfully magnetic, and, if we bring near to its ends the piece of soft iron, A (generally called an armature or keeper), this will be attracted with great tenacity, and heavy weights, W, may be suspended therefrom. This, bear in mind, is the most simple form of horseshoe electro-magnet, and not exactly of the kind which formed part of me, as you will now perceive. As the production of Pixii, my upper part, or head if I may so term it, was formed of an electro-magnet, M, M, attached to the top of a framework and underneath were my lower extremities, or legs of a permanent magnet, P, P, arranged to rotate with great rapidity by means of a toothed wheel and pinion. Like some neglected infants I was brought up, or, more strictly speaking, turned, by hand, and my energy was displayed not as in the case of the unattended babes to whom I have just alluded, by the strength of my lungs, but in the production of certain physiological effects which I took good care should make themselves felt by those who handled me carelessly or whose touch was directed to an unprotected part.



MY PIXII FORM.

In other words, electric currents were obtained from me of sufficient intensity to produce small sparks and

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to give severe shocks to those who came in contact with certain portions of my anatomy, to wit, the wires, *a* and *b*, which you notice hanging from me.

I admit freely it was a shocking beginning, but for that Pixii must be held responsible.

I may add *en passant*, that the intensity of these currents and therefore the effect I produced upon the unwary, depended upon the strength of the magnets and the closeness of their extremities to the ends of the electro-magnets. Retracing my steps for a moment: you have not forgotten what I impressed upon you but a short time since respecting the currents produced in a coil when a magnet is inserted and withdrawn very rapidly. Good! your memory serves you well; the currents were in *opposite* directions.

Now my Pixii form produced these very same currents which, for such purposes as medical applications, answered very well; but to make me of universal service it became necessary that something should be done to enable me to convert these opposite or alternating electrical impulses into *continuous* currents, or those which are said to flow in the same direction as from that more ancient source of electrical energy, the galvanic battery. For such purposes as electro-plating, electro-typing, chemical decomposition, the electrical transmission of power, &c., it became absolutely necessary that I should be able to do all that of which a galvanic cell is capable.

This want was met by the invention of an ingenious device technically called a *commutator*, or, as we may in plain language term it, a current changer. It was then possible to turn the alternating currents which, by virtue of my form, I produced, into those which passed continually in the same direction.

Thanks to Hyppolyte Pixii, therefore, I became the very first exponent of the great Faraday's investigations, and I have naturally cherished a far greater affection for him who first saw what could be made of the germ which he nurtured to such purpose than for the many who changed me little by little into what you behold me now.

I was not, as you may imagine, long left in this primitive form, for a Mr. Saxton came upon the scene, and, taking advantage of my youth and inexperience, so beguiled me that in the end he completely turned my head. After such an admission as this, you will readily understand that I made but a feeble resistance to the liberties which he further took with me and which I hereby disclose to you.

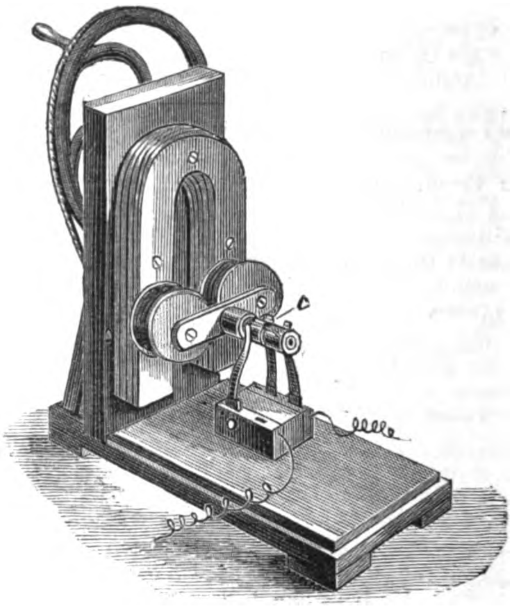
When I state that this gentleman completely turned my head it is only another way of telling you that he reversed the form in which Pixii had modelled me, and made my head—that was—turn in the place of my lower extremities. This, I candidly confess to you, was an advantage, although I did not look upon it as such at the time; for being light headed I did not in this, the second stage of my being, necessitate the expenditure of so much muscular energy to produce the same results as previously. The extent to which I was mutilated by Saxton can thus be easily detected in this new portrait of my early youth.

You may infer therefrom that my original head was placed, not exactly between my legs it is true, but beneath my feet. You think the non-technical reader will be in some perplexity respecting the manner in which the currents produced within me could, by the commutator, be taken from me as it were? Well, I will briefly enter into the details of that part of me which shall make this clear.

Before doing this I will first of all show you my third adaptation, which took place at the hands of a Mr. Clarke, but two years after my birth.

It occurred to this gentleman that I might be made to give varying effects if he constructed the electro-magnet portion of my frame in duplicate; one set coiled with thick and the other with thin wire. He correctly estimated my capacity and was thus enabled to make my performances of a still more astounding character to the scientists of the day. He also altered the positions of my component parts, as you doubtless notice in this sketch.

The commutator which you request me to explain is shown by the letter *c*, as in my Pixii form.



CLARKE'S ADAPTATION.

Too small you think? Well you shall have a commutator enlarged, and in order that you may all the more thoroughly understand my *modus operandi* I will, at the risk of being thought too technical when I have all along professed to be speaking in plain terms, show you precisely how the revolutions of the electro-magnets in front of the permanent magnet gave rise to those alternating currents which it became so desirable to *commutate*.

(*To be continued.*)

DYNAMO-ELECTRIC MACHINES.*

By JOHN HOPKINSON, D.Sc., F.R.S., and EDWARD HOPKINSON, D.Sc.

OMITTING the inductive effects of the current in the armature itself, all the properties of a dynamo machine are most conveniently deduced from a statement of the relation between the magnetic field and the magnetising force required to produce that field. This relation given it is easy to deduce what the result will be in all employments of the machine, also the result of varying the winding of the machine in armature or magnets. The magnetic field may be expressed algebraically as a function of the magnetising force, or more conveniently by a curve ("Proceedings of the Institution of Mechanical Engineers," April, 1879, p. 246). Amongst the empirical formulæ which have been proposed to express the electromotive force of dynamo machines in terms of the currents around the magnets, we may mention that known as Fröhlich's, where $E = \frac{a\,c}{1 + b\,c}$, E being the electromotive force of the machine at a given speed, c the exciting current, and a and b constants. For some machines this hyperbola is said to express observed results fairly accurately. In our experience it does not sufficiently approximate to a straight line in the part of the curve near the origin, and gives too high results for large values of c.

One purpose of the present investigation is to give an approximately complete construction of the characteristic curve of a dynamo of given form from the ordinary laws of electro-magnetism and the known properties of iron. Let n be the number of convolutions on the magnets, c the current round the magnets, l_1 the mean length of the lines of force in the iron of the armature, A_1 the area of section of iron in the armature, l_2 the distance from iron of armature to iron of pole pieces, A_2 the area of the magnetic field in which the wires move corrected for its extension round the edge of the pole pieces, l_3 the total length of the magnet cores, A_3 the area of the magnet cores, l_4 the mean length of lines of force in the yoke connecting the magnet limbs in machines of the type on which we have principally experimented, A_4 the area of section of the yoke, l_5 the mean length of the lines of force in each pole piece, A_5 the mean area of section of pole piece, I the total induction through the armature, when no current passes in the arma-

* Abstract of paper received by the Royal Society, April 6th, 1886.

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ture, and ν I the total induction in the magnet cores; and finally let the relation between the magnetic force (a) and induction (α) (*vide* Thomson, "Electrostatics and Magnetism, p. 397, and Maxwell, "Treatise on Electricity and Magnetism," vol. ii., p. 24) be represented by the equation $\alpha = f(a)$, then the characteristic curve is—

$$4 \pi n c = l_1 f\left(\frac{I}{A_1}\right) + 2 l_2 \frac{I}{A_2} + l_3 f\left(\frac{\nu I}{A_3}\right) + l_4 f\left(\frac{\nu I}{A_4}\right) + 2 l_5 f\left(\frac{I_5}{A_5}\right)$$

If the relation between a and α be given in the form of a curve, this formula indicates at once a perfectly simple graphical construction for the characteristic. Taking the curve of magnetisation determined by one of us for wrought iron, and constructing a characteristic in this way, we have obtained a theoretical curve which agrees over a long range with the actual results of observation on a dynamo machine more closely than any empirical formula with which we are acquainted.

To determine ν, a wire was taken once round the middle of one magnet and connected to a ballistic galvanometer, a known current was then either suddenly passed round the magnets or short circuited, the elongation of the galvanometer being noted. A similar observation was made with the same current, the galvanometer being connected to a single convolution of the armature in the plane of commutation. The ratio of the two elongations is the value of ν.

The distribution of the waste field $(\nu - 1)$ I was roughly ascertained in a similar manner.

The currents in the fixed coils round the magnets are not the only magnetising forces applied in a dynamo machine. The currents in the moving coils of the armature have also their effect upon the resultant field. In well-constructed machines the effect of the latter is reduced to a minimum, but it can be by no means neglected. This introduces a second independent variable, viz., C, the current in the armature. The effect of the current in the armature depends upon the lead given to the brushes. Denote this by λ, which we may also regard as an independent variable, as it is subject to arbitrary adjustment.

If $I = F(4 \pi n c)$ be the characteristic curve when no current passes through the armature, then

$$I + \frac{\nu - 1}{\nu} 4 \lambda m C \frac{A_2}{l_2} = F\left(4 \pi n c - \frac{4 \lambda m C}{\nu}\right),$$

where m is the number of convolutions in the armature. Here we omit the comparatively unimportant portion of the magnetic force in the core of the armature and the pole pieces. From this formula it is not difficult to deduce a geometrical construction for the characteristic surface (*vide* "Practical Applications of Electricity," Lectures delivered at the Institute of Civil Engineers, 1882–83, p. 98). The equation may be thus expressed in words, if λ be such that the coils at commutation embrace the whole, or nearly the whole, induction. The effect of the current in the armature upon the difference of potential between the brushes of any machine, is the same as that of an addition to the resistance of the armature proportional to the lead of the brushes, and to the ratio of the waste field to the total field, combined with that of taking the main current $\frac{m \lambda}{\nu \pi}$ times round magnets in a direction opposite to the current, c. Many consequences can be deduced, of which we may notice the following:—In a series-wound dynamo C is equal to c, and if c be increased beyond a certain point, I must attain a maximum and then diminish; this has been frequently observed. We now see that it depends upon the existence of a waste field. Secondly, let the coils of the magnets be entirely disconnected, and let λ be the negative: if the armature be short circuited through a small resistance and be run at a sufficient speed, a large current may be produced in the armature. This latter deduction we have verified by direct experiment.

The efficiency of the type of dynamo machine upon which the experiments before indicated have been made, has been accurately determined by the device of coupling two similar machines, both mechanically and electrically, so that one should act as a generator of electricity, driving the other electrically, whilst the latter acted as a motor driving the former mechanically; the loss of power required to keep the whole combination in movement being determined by direct dynamometric measurement, and the power passing electrically from the one machine to the other being measured by ordinary electrical appliances.

The whole of the experiments were carried out at the works of Messrs. Mather and Platt, to whom we are indebted for the exceptional opportunities we have enjoyed of putting theoretical conclusions to the test of experiment on an engineering scale.

East of Scotland Engineering Association.—The members of this association met recently at the Waverley Station, and were first shown over the electric installation there, under the guidance of Mr. Thomas Carswell, who explained the arrangement and methods employed. This gentleman afterwards read a paper entitled, "Some methods used in practical electric lighting," in which he described several of the different systems used by the various electric companies. After considerable discussion, a hearty vote of thanks was awarded to Mr. Carswell.

REVIEW.

Theoretical-Practical Manual for the Electrician. (Manuale Theorico-pratico dell' Elettricista.) Milan: Office of the *Elettricita.*

This work, which is illustrated with 86 woodcuts, is due to several authors. The preface is from the pen of E. Bignami. P. Meardi contributes the section on lightning conductors; T. Bonadiman expounds the galvano-plastic art; A. Martinelli discusses the domestic applications of electricity, such as bells and other indicators and alarms; Dr. A. Pellini describes telephones and microphones; P. Meardi gives an account of the electric light; and Prof. Gandini discusses accumulators. All these various applications of electric science are dealt with very clearly, and as fully as is compatible with the size of the book. The object of the various authors is plainly more practical than theoretical, and they evidently pre-suppose in their readers an acquaintance with the general principles of the science. Towards the conclusion of the section on galvano-plastie we find a curious passage bearing on the question of lighting, private and public. Signor Bonadiman writes:—"The preparation of magnesium at a relatively low price will have a great industrial importance, especially for lighting purposes. According to Roscoe, 72 grms. of magnesium give as much light as 10 kilos. of stearine candles. At present the price of magnesium is still too high (450 lire per kilo. = about £8 11s. per lb.), and its light is still much too dear as compared with that of candles. But if it can be prepared at the twentieth of its present figure, which will be obtained in time, the magnesium light will become very economical and advantageous. Electricity will then be seen co-operating with its own peculiar action in dethroning itself." To this we may add that the magnesium light, in point of purity and whiteness, is the best substitute for daylight yet devised, and that, according to recent reports, a very great step towards the necessary reduction in cost has just been effected. It will be a curious and unexpected result if electricity should be found to give more light when employed in the preparation of magnesium than in direct illumination. The illustrations of this manual are judiciously selected and well executed.

NOTES.

The Electric Lighting Bills.—In the House of Lords, on Thursday, the 15th inst., the Earl of Camperdown presented a petition from the Vestry of the Hamlet of Mile-end Old Town against alteration of Section 27 of the Electric Lighting Act, 1882. The Duke of Abercorn, at the same time, presented a petition from the Society for the Encouragement of Arts against the Government Bill for the amendment of the Electric Lighting Act of 1882.

The Colchester Electric Lighting.—Attempts have been made to form a new company, locally, to continue the electric lighting business entered into at Colchester by the now dissolving South-Eastern Brush Electric Light Company, and a recent meeting of the consumers was held to discuss the matter. Mr. E. Thompson Smith advocated the formation of a new company, and asked whether the consumers were willing that the lighting should be stopped for a period pending such alterations and additions as might, under the new system, be found necessary. It seems, however, that an undertaking had been entered into by the Electric Lighting Company to return 75 per cent. of the value of the fittings, should the lighting cease, and this 75 per cent. the consumers are anxious to obtain, so they declined to enter upon any new scheme until they had quite done with the liquidator of the South-Eastern Brush Company.

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Incandescent Lamps in Mines.—An underground engine-room and other deep workings in one of the Ecton mines, Staffordshire, have been supplied with electric lamps during the present month, which have effected considerable saving as against oil lamps and candles. Lamps of 20 and 50 candle-power are used, and the wires run on insulators fastened into the rock. The dynamo has been manufactured by Messrs. Holmes and Co., and is a new type of compound self-regulating machine, with capacity of 30 ampères at 60 volts. The installation has been carried out by Mr. J. H. Bowman, electric engineer, of Alport Bakewell, and is giving great satisfaction.

Electric Lighting of the Tilbury Docks.—The new docks of the East and West India Dock Company at Tilbury, which were opened last Saturday, contain, perhaps, the largest installation of electric lighting in the world. In the out-door portion of the docks 80 arc lamps of 3,000 C.P. each are employed, many of them being placed on posts 50 feet high. To prevent shadows being thrown by the lamps, a new suspending arrangement has been employed, the invention of the contractors, Messrs. R. E. Crompton and Co., whereby the lamp is placed immediately over the top of the pole. Incandescent lamps, 1,362 in number, are used in the various sorting and storing sheds, the general offices, the canteen, and elsewhere. They are of from 16 to 22 C.P. Portable lights are also available in the sorting sheds, and groups of lamps are supplied for placing on steamers when unloading. Five engines and boilers are employed, and they are capable of a maximum output of 500 effective H.P. There are 16 dynamos of the Crompton type, which is now well known. They are driven from counter-shafting by belts of the quality known as the "Shortlap Hoyt," supplied by Messrs. Balderston, and great care has been taken to so arrange the whole plant as to reduce any part to a minimum risk from accident or breakdown. The disposition of the lights over the docks has been made in such a way as to illuminate brilliantly those parts that are most likely to be in use at any particular time. The quays and railway sidings are thus well provided for, and large lanterns are fixed in positions most suitable for unloading, &c. The large hotel which has been erected just outside the docks has also been fitted throughout with incandescent lamps. The whole of the lights in use in the docks can be controlled by the engineer in charge, as the main switch-boards are placed in convenient positions in the engine-house. The arrangement of these switch-boards with cut-outs and other appliances attached are of the most elaborate nature.

Electric Lighting of the Exeter Lunatic Asylum.—The Consolidated Electric Company, which last year obtained the contract for lighting the new lunatic asylum just erected for the Exeter Corporation, having gone into liquidation, it has become necessary for the Corporation to "make other arrangements." The Asylum Committee, however, still believes that the "electric light, from a proper installation, is brilliant, reliable, perfectly safe, and under control," for it has recommended that the tender of Messrs. Woodhouse and Rawson, which was next in amount to that of the Consolidated Company, should now be accepted. Messrs. Woodhouse and Rawson have offered to take over the contract of the defunct company, with slight alterations, and, although several councillors spoke somewhat strongly against the electric light and suggested that gas should be employed, their offer has been accepted. The terms are £1,945, and £210 per annum to maintain the whole of the plant in good working order for seven years.

Military Use of the Telephone.—We understand that, in connection with the manœuvres which are to be carried out on Easter Monday and two or three preceding days in the vicinity of Portsmouth, the telephone will play a rather important part. The different forts which are to be garrisoned by the defending force, will be connected by wire, so that the approach of the enemy and other messages of an important description, may be promptly circulated. The necessary apparatus is to be fitted by the Western Counties and South Wales Telephone Company.

Telephone Experiments.—The efficiency of the telephone for moderate distance communication was put to the test at Portsmouth last week, in connection with a lecture delivered by Mr. J. H. Sandy, the local manager of the Western Counties and South Wales Telephone Company. By the permission of Mr. Goldston, telegraph superintendent to the railway company, Mr. Sandy was permitted to make use of the railway telegraph wires. The wires from the Protestant Hall were connected at the Portsmouth Town Railway Station, and at Southampton, twenty-four miles distant, the telephone agent was in attendance to speak through. In order that the audience might have an opportunity of judging for themselves, extra receivers were placed in the hands of several of their number, who expressed themselves thoroughly satisfied with the experiment.

The Meucci Telephone.—A company has been formed, called the Citizens' Telephone of Newark, N.J., for the purpose of doing a general telephone exchange business, and it is said that the construction of lines will be begun as soon as 300 subscribers have been obtained. It is said that 100 of these were secured in one day. The new company claims that the rentals will be 30 per cent. less than those charged by the Bell Telephone Company. The Meucci telephone will, it is said, be used, but not, we presume, the original form of that instrument.

The Telephone on Board Ship.—Capt. J. D. Randall, master of the steamer *Enquirer*, of Memphis, Tenn., claims to be the first to employ the telephone on board of a steamboat. His steamer, when at the landing, is connected with the exchange, and the arrangement is found to be very convenient. The telephone is "grounded" in water and works very well. As it is not possible for the river steamers to land at the city wharf every day in the same place, a wire is strung up and down the river, and from each pole a loose wire hangs down, to which connection is made. From that it runs to the boom of the stage rigger, at the bottom of which a wire is connected to the telephone in the office of the steamer.

Our correspondent in the North of England who recently gave us some information respecting telephones on board a steamer, will probably recognise the difference between the installation of which he spoke and that mentioned here, where communication with the shore was the great point aimed at.

Cable Rates.—It is announced that the Eastern Telegraph Company will reduce rates to several stations on July 1st.

Atlantic Cable Broken.—A telegram from New York announces a fracture in the French cable about 220 miles from Duxbury.

Atlantic Cable Competition.—A further reduction in the Atlantic cable rates is announced. The Western Union Telegraph Company informs us that on and after the 5th May next the rate for telegrams to New York and most of the principal telegraph stations in North America will be reduced to sixpence per word; and the Direct United States Cable Company also sends a communication to the same effect, with the additional information that special arrangements may be made for the transmission of Press messages at threepence per word. The other companies which have a share in the "pool" arrangement have also reduced to 6d. per word. We would suggest to the Commercial Cable Company that it may possibly be the wiser plan to maintain its present rate; or, at all events, to devote one cable to messages at an increased charge, such messages to have precedence of all other matter.

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SS. "Buccaneer."—Early in the month this ship arrived at her moorings off the works of the India Rubber and Gutta Percha Company at Silvertown after a cruise of nearly six months duration. The ship is not only fitted with the machinery necessary for cable work, her light draught making her very handy for landing shore ends on a shoal coast, and for river work; but she also has every appliance for ocean research as the work she has lately been engaged in had for its object, besides the selection of the best ground for cable laying, the solution of many problems connected with the bed of the Atlantic on the African side. We understand that the soundings and observations carried out under the direction of Mr. J. T. Buchanan, and which extend over a large tract of hitherto unexplored ocean, have resulted in the acquirement of most interesting additions to the science of marine biology and to the knowledge of currents along the African coast, more especially with regard to the equatorial current. Mr. Buchanan has been assisted by Mr. J. Rattray, naturalist, and some of the Silvertown staff, including an analytical chemist; the actual work, the preparation of specimens, and the recording observations and results, necessitating a comparatively numerous body of assistants. The results which most interest the West African Telegraph Company (under contract with whom the Silvertown Company is carrying out the work of establishing telegraphic communication along the African coast) are those which relate to the soundings. These show throughout the whole route to be followed by the cables, a splendid bottom of soft mud and globugerina ooze, with the exception of two places where rocky ground is met with, but which can be easily avoided owing to the information now acquired. We trust that Mr. Buchanan will publish the results of his observations, which must be of special interest with regard to the Gulf of Guinea, the ocean bed in the neighbourhood of the islands of Principe and St. Thomé, the debouchure of the Congo, and the researches on the equatorial current. The necessity of carefully selecting men, and also of carefully looking after them, on an expedition of this nature, where the climate is so adverse, was never more fully demonstrated, and it is due to the fact that officers and men were chosen not only with regard to their abilities, but also with consideration as to their physique (the weaker ones being weeded out and transferred to the other ships while on the coast), that no sickness was experienced during the cruise, and it must be remembered that the work of sounding, taking serial temperatures, and observing the force and direction of currents involves no slight amount of labour and exposure.

The "Naniwa Kan."—Mr. A. A. Campbell Swinton writes to us to point out several inaccuracies in our paragraph concerning this cruiser which appeared in our issue of the 16th inst. The steering gear is hydraulic, not electrical, as stated. There are no less than four search light projectors, two being on the forward and two on the after bridge. The engine room telegraphs are of the ordinary mechanical type. The guns, as well as the torpedo tubes, are fitted with electric firing gear, so that by pressing a key in the conning tower a broadside of five guns can be simultaneously discharged. The whole of the lighting and other electrical installations have been carried out by the electrical department of Messrs. Sir W. G. Armstrong, Mitchell & Co., who built and fitted out this most redoubtable vessel.

Progress in Electrical Tramcars.—We hear on good authority that Mr. Reckenzaun has received definite orders for no less than twenty 1-horse cars for German tramways. We trust that this success abroad will give increased confidence in electric locomotion in our country.

Notice of Removal.—The Western Electric Company notifies a removal to new premises at 79, Coleman Street, E.C.

Electricity in Shipbuilding Yards.—Messrs. Sir W. G. Armstrong, Mitchell & Co., of Newcastle-on-Tyne, the famous manufacturers of ordnance and builders of ships of war, have an electrical department included in their vast establishment. Among other works, they have recently completed an extensive installation of incandescent lamps in their drawing offices, above 200 lamps being employed. They have also lately fitted up two large Japanese cruisers with incandescent and search arc lamps, and have at present in hand a similar and very extensive installation on a large Chilian ironclad. They have, moreover, adopted electric arc lighting in their new steel works and metal foundry, and also in their recently finished Elswick shipyard, and in the latter make extensive use of temporary installations of incandescent lamps for the interior illumination of war ships in course of construction. Electricity is also employed in connection with the chronographs used for determining the velocity of the shot fired at their proof ranges, and also for the measurement of the temperature of some of their furnaces. There is a complete system of telephonic and telegraphic communication between the various departments, there being no less than 21 separate sets of instruments in connection with the establishment. When it is remembered that the Elswick part of their works is in itself over a mile in length, the advantages of the above becomes immediately apparent.

Newspaper Science.—We read in the *Swansea Cambrian* of the 9th inst., that "there is a defect in electric lighting which the researches of specialists and their experiments have failed to overcome. *That is the vacum (sic) which every now and then occurs in even the most powerful systems of incandescent lighting, causing a constant failure in the steadiness of the gleam.*"

Railway Benevolent Institution.—We have been requested to state that the annual dinner in connection with this institution will take place at the Freemasons' Tavern, London, on Wednesday evening, the 12th May, under the presidency of John Dent Dent, Esq., Chairman of the North Eastern Railway Company. The institution has been established to provide for the necessitous members, orphans, children, and widows of the railway officers and servants in the United Kingdom. We understand that a special fund in connection with Mr. Dent's presidency is being raised, and that it has been arranged that subscriptions may be addressed to Mr. Dent, at the company's office, York.

The City and Electric Lighting.—At last Tuesday's meeting of the Commissioners of Sewers, the Remembrancer (Mr. G. P. Goldney) reported that three electric lighting Bills had been introduced in the House of Lords. He thought it necessary that the Commission should be in a position to tender evidence, as he imagined they had a larger experience in the electric lighting of towns than any other authority. He had, in fact, been requested by one of the peers to make arrangements for evidence to be given by the Commission. He did not propose that they should embark on a costly inquiry, but it was quite possible the Engineer's opinion might be desired by the committee. He had drawn up a short petition to enable them to bring forward witnesses, which he asked the Court to sign. The petition was signed accordingly.

The Edison-Bergmann Transmitter.—A correspondent writes to us respecting this apparatus which was illustrated in our last:—"Be good enough to show the connections in the different parts of the transmitter and show how the centre of the spindle can regulate the screw, rigidly supported and bedded in the front of the case, for I am puzzled." As we remarked in our "Notes" last week, p. 354, our illustrations were taken from an American contemporary; we cannot supply any further particulars.

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The Electric Lighting Bills.—The Select Committee of the House of Lords upon the three electric lighting Bills is composed of the Earl of Camperdown (chairman), Earl Cowper, the Earl of Crawford and Balcarres, Viscount Bury, Lord Balfour of Burleigh, Lord Methuen, Lord Houghton, Lord Rayleigh, and Lord Lingen. The Committee will commence its inquiry on May 10th.

Telephonic "At Homes."—During the past week the Northern District Telephone Company has had an exceptionally busy time, the trunk lines between Middlesborough and Stockton, and Stockton and Hartlepool having been opened. These events were celebrated by telephonic "at homes," given at the three towns, namely, at Middlesborough on Wednesday, Stockton on Thursday, and Hartlepool on Friday. The invitations issued by Mr. Clay, the manager of the company, were taken advantage of to a large extent, as shown by the large and fashionable audience on each evening. The Theatre Royal at Middlesborough being connected, the performances given by the Royal English Opera Company were distinctly heard and much appreciated each evening; and, when it is stated that every word and note of music could be heard at Hartlepool (a distance of rather over 19 miles) just as plainly as at the company's exchange at Middlesborough, further comment upon the excellent way in which the line has been erected is unnecessary.

Telephonic Rates.—The Glasgow corn merchants who are connected with the exchange of the National Telephone Company, have resolved to cease their subscriptions at the close of their existing contracts with the company, unless they have an undertaking that the annual charge shall not exceed £15.

Fire at the Liverpool Telephone Exchange.—One day last week a fire occurred in the telephone exchange at Liverpool, resulting in the almost total destruction of the plant. Considerable skill and energy have since been displayed by the officials in repairing the damage caused by the fire. In five days afterwards, all the complicated arrangements were again got into working order. Upwards of 20 miles length of wire had been destroyed. 1,800 wires had to be cut away, having been soldered together by the intense heat, and much difficulty was experienced in finding out the owners of them. The electrician had 5,000 sections to arrange, and 3,000 of them were soldered together as above stated. Mr. W. A. Sharp, the electrician, and Mr. Rowe, the engineer, have earned the thanks of the subscribers and the company for the energy they displayed in so rapidly repairing the damage.

Telephone Exchanges.—The National Telephone Company has decided to establish an exchange in Dunfermline, giving communication with Glasgow, Alloa, Stirling, Falkirk, Dundee and Kirkcaldy.

Telephone Extension to Greenock.—The building of the telephone line from Glasgow to Port Glasgow and Greenock makes good progress and will shortly be opened for traffic. The new line will give a more extended service to the subscribers at Greenock and Port Glasgow, and will also enable the National Telephone Company to discontinue the renting of the two post office wires between Glasgow and Greenock.

The Edinburgh Exhibition.—The electric railway is to be laid down in the northern portion of the grounds, and will run under the line of trees between the east and west entrances. The North Metropolitan Tramways Company, London, will give the use, free of charge, of two of its finest cars: the motive power will be supplied by one of Marshall's engines; and the electricity will be provided by King, Brown & Co.

Trials were made on Monday afternoon and evening with the Thomson-Houston electric light in the permanent building of the International Exhibition at Edinburgh. The installation is divided over three circuits —supplied by different dynamo machines—so that in the event of there being a mishap in any of the circuits the other two may remain intact. Circuit after circuit was tried, and success followed success. Lord Dean of Guild Gowans, chairman of the Executive Council, as well as several members of the council, were present, and all of them testified to the success of the system, which, if exception be made of an installation in Glasgow, is new to Scotland. Besides the permanent building, several of the courts and part of the pleasure grounds will be lighted by the Thomson-Houston Company.

The first trial of the electric light in section D of the International Exhibition, Edinburgh, was made on Thursday week by the Anglo-American Brush Electric Light Corporation, in the presence of Mr. Carey, the engineer, Mr. Bryson, who has the superintendence of the electric lighting, and others, and proved highly satisfactory.

Our Correspondence Columns.—From the date of our present issue to that of our next the Easter holidays will intervene. Bearing this in mind, we shall be glad if our correspondents will be so good as to send their communications to us by Tuesday morning, so as to ensure insertion next week. We have several letters which we are compelled to hold over, one being from Messrs. R. E. Crompton & Co., in reply to our editorial comments on the tests made with one of the firm's dynamos.

The Shooting of an Electrician.—A despatch from Boston, of April 3rd, says:—"Henry K. Goodwin, the inventor, whose trial at Salem, a few months ago, for the shooting of Albert D. Swan, of the Lawrence Telephone Company, is to receive a life sentence for murder in the second degree." Our readers may remember that we notified the crime at the time of its occurrence.

Restoration of Magnetism by Heat.—Writing to the *Scientific American*, Mr. Chas. H. Roberts says:—"To heat a magnet to a red heat has long been known to destroy its magnetism; but from a recent experiment of mine with two sound magnets that have from want of care lost nearly all their magnetism, I fully restored them by rubbing a red hot iron, ¼ inch, over them until it had become quite cool. The magnets are better now than when new. This experiment was prompted in my desire to prove magnetism bears to heat as close a relation as electricity. Thus we hope soon to be able to make a clearer demonstration."

Another Death from Electricity.—A short time ago, a man, named Coyle, was killed in America whilst making an electric light wire connection in front of a shoe store. The coroner's jury found that death was caused by the carelessness of the deceased.

A Telegraphist Killed at Clovelly.—Last Friday afternoon Mr. Knight, a clerk in the Central Telegraph Office, London, was walking with a friend along the cliffs near the romantic Devonshire village of Clovelly, when he attempted to reach some object on the edge of the cliffs, and fell over. He was picked up 100 feet below. His death must have been instantaneous. He arrived at Clovelly on the previous day to spend his Easter holidays.

To our Readers.—It may interest our subscribers and others to know that a very handy reading case has been prepared, in which the whole of the half year's numbers of the ELECTRICAL REVIEW can be filed until the volume is ready for binding. Particulars may be gathered from advertisement on page 10 facing "leader."

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Still Another Telephone.—The following telegram from Youngstown, Ohio, appeared in the Chicago papers under date of March 30th:—"A practical test of the new telephone transmitter of the Rose Electric Company was made yesterday under conditions that demonstrate beyond a doubt its superiority over the Bell instrument now in common use. For some time the inventor, Lucien C. Rose, has been secretly at work, and recently the Inventors' Aid Association of this city undertook to assist him. Under its direction application has been made for a patent, and pending the consideration of the case the practical tests referred to were made. The transmitter and receiver resemble in outward appearance those of the Bell instrument, but within there is a difference known only to the inventor. The experiment was successful in every particular, conversation being carried on with perfect ease over the immense length of wire. At no time was it necessary to raise the voice above the pitch used in common conversation. A similar experiment was tried a few weeks ago, when a circuit of 960 miles was used, and this also proved successful. The company is now getting ready for a more thorough test."

A Victory for the Bell Company.—A dispatch of April 5th, from Philadelphia, says:—"In the United States Circuit Court, before Judges McKennan and Butler, argument was to-day heard upon the petition filed by counsel for the Clay Commercial Telephone Company, which asked to have annulled the restraining order issued in the suit of the Bell telephone Company against the defendants. The prayer of the petition was dismissed, and the counsel for the Bell Company was asked by the Court to prepare a final decree in favour of his client and to submit it to the Court tomorrow, so that the appeal of the case to the Supreme Court of the United States could be expedited."

Telephone Exchanges in Western Australia.—According to the *West Australian* of March 8th, the colony in which that journal circulates is putting forth big efforts to make up the distance she has lagged behind her sister colonies in the matters of telegraph communications and railway facilities, and is also now determined not to be behind in making use of the telephone. The Government was taking active steps towards establishing telephone exchanges in Perth and Fremantle. The services of Mr. William J. Hancock, A.S.T.E., of Dublin, had been secured as superintendent of telephones, and that gentleman arrived in Perth about a month before the date given above to commence his duties. Mr. Hancock has had considerable experience in the working of telephones in connection with the Dublin Exchange, which has about 900 subscribers, who use it to the extent of about 7,000 messages per diem. Since his arrival in Perth Mr. Hancock has superintended the construction of telephonic communication between Government House and the office of the Colonial Secretary. He is now making arrangements for the organising of an exchange in Perth and another in Fremantle. In course of time it is intended that a couple of trunk lines shall be run between Fremantle and Perth, so that the subscribers in the two towns may be able to converse with each other as occasion requires. It had not been decided what should be the rent to subscribers, but should there be a fair number of them—say a hundred—in each town, it would probably, our informant states, be fixed at the low sum of £16. The telephone that will most likely be employed is the Bell and Blake magneto instrument.

Self-Induction Experiments.—Mr. Sydney F. Shelbourne, of New York, writes to the *Electrical World* respecting the researches on self-induction which Prof. Hughes has just made public: "The resulting facts made public by him illustrate one thing pretty clearly. It is the difference of spirit and motive with which scientific experimenters in England and other parts of Europe undertake their work as compared with those of the United States. Here it is general practical utility and the endeavour to make the subject pay through the Patent Office. There it is more largely the amateur spirit which partakes of true science, looking mainly to the general reward of reputation, honour, and philosophic recognition. I am sorry to admit that the comparison touches myself as well as other Americans, for no sooner did I see your first editorial notice of Prof. Hughes's address and the experiments he describes, than I immediately turned among my samples to find an old model of a conductor which I had prepared in the autumn of 1883 for the purpose of urging its adoption upon the Postal Telegraph Company, then desiring to lay in Washington, D. C., underground conductors, embracing some heavy ones to be used for their automatic telegraphy, and in which they desired to avoid as much as possible the effects of induction. I had reasoned out theoretically the same conclusions arrived at by Prof. Hughes as to the advantage of dividing the current between a number of parallel conductors, separated from each other in whole or in part, except at the ends, and used as one conductor. The conducting core of my model was composed as follows: A copper wire lightly insulated with winding of paraffined cotton formed the centre; around this was placed four strands of bare copper wire of the same size as the centre wire, No. 18, Am. G. Each strand was made of two wires twisted together. It will be seen that these four strands did not fully occupy all the space around the centre insulated wire so as to touch each other laterally at every point, but that the random contacts between them will be at uncertain intervals, and that a strand of two wires always leave spaces or depressions at the steps of the twists which would largely separate the wires of any two strands even though in general contact, side by side. With such a conductor, composed, as in this case, of nine wires, and then insulated as a whole, I reasoned that I could accomplish the results now so beautifully declared by the experiments of Prof. Hughes. Unfortunately for my theories and propositions, which were urged before Mr. E. A. Leslie, then one of the electricians of the Postal Company, the appreciation was not cordial or satisfactory to me, and the Postal Company did not care to order any of my conductors for their Washington line, so that my model was returned to the pile of samples in my office and dismissed from my thought until the announcement of Prof. Hughes's experiments."

Government or Private Control.—A recent issue of the New York *Electrical World* contains the following: "Our esteemed London contemporary, the Electrical Review, makes a warm and eloquent defence of English originality and inventiveness in the electrical field, the occasion of its remarks being a recent little note of ours on the remarkable growth of telegraphy and telephony during the last sixteen years in this country, where electrical applications are unchecked by governmental interference or monopoly. The fact is, as we readily and gladly admit, that England is well to the front in all electrical invention and enterprise, and has a most honourable and enviable record. But we think that she has nevertheless suffered greatly from having her telegraph and telephone service in governmental hands. This opinion, too, is not held solely in America, neither is it in any way disparaging to the many able officials who are to be found carrying out efficiently and with intelligence the heavy work of their respective departments."

Science in Germany.—The Berlin correspondent of the *Standard* says:—"Dr. Werner Siemens has presented to the Government a sum of 500,000 marks (£25,000) to establish an institute for the carrying on of experiments in natural science."

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NEW COMPANIES REGISTERED.

Shipping Appliances Company, Limited.—Capital, £10,000, in £10 shares. Object: To purchase the business of supplying signalling apparatus and other shipping appliances belonging to Mr. John Sachverall Gisborne, of 66, Finsbury Pavement, the purchase to include the letters patent No. 311, of 1885, for electrical signalling apparatus. Signatories: R. Bourne Atherley, Wallington, Surrey, 25 shares; H. T. Hanson, 11, Old Broad Street, 25 shares; J. Gibb, 2, Blackheath Rise, 10 shares; W. T. H. Radford, 2, Fenchurch Avenue, 5 shares; W. T. Lockhart, C.E., 7, Fenchurch Street, 10 shares; F. G. Arbuthnot, 66, Finsbury Pavement, 10 shares; F. Tate, 7, Fenchurch Street, 5 shares. Registered on the 16th inst. without articles of association by Messrs. Waterlow, Bros., and Layton, Birchin Lane, Cornhill.

Leslie Liardet, Limited.—Capital, £8,000 in £10 shares. Objects: To manufacture mechanical, electrical, or other gear used in connection with ships, boats, railways, wharves, warehouses, &c.; and, for the sum of £70 cash and the issue of 793 fully paid shares to purchase the patents of Liardet's disengaging hooks (No. 597, dated 27th September, 1883), and of Liardet's improvements in rudders and rudder fittings (provisional protection No. 11,196, dated 21st September, 1885). Signatories (with one share each): H. W. Royle, Cricklewood; A. C. Baber, Broadstairs; J. W. Postlethwaite, 7, Old Burlington Street; E. Samson, 1, Lincoln's Inn Fields; R. Warner, 10, Priory Road, Kilburn; J. Banks, 58, The Grove, Gamberwell; G. E. Baker, 6, Guildhall Chambers. The signatories are to appoint the first directors; qualification, 20 shares; remuneration, £200 per annum whenever the profits admit the payment of £6 per cent. per annum dividend. Registered 17th inst. by Mr. E. Samson, 3, Gracechurch Street.

Miners' Electric Safety Lamp Company, Limited.—Capital, £100,000 in £1 shares. Objects: To purchase from Benjamin Nicholson, of 57, Coleman Street, the right to use for mining purposes certain patent rights granted for improvements in batteries for generating electricity, and for telegraphic, telephonic, and other purposes. Signatories (with one share each), S. C. Woodley, 5, Montern Road, Forest Hill; F. J. King, Northumberland Park, Tottenham; T. Ford, 1, Milton Villas, West Green Road, Tottenham; G. W. Cook, 3, Swan Buildings, Moorgate Street; A. E. A. Nicholson, The Torrs, South Norwood; S. Innes, 94, Manor Street, Clapham. Registered, 20th inst., by Messrs. Burns and Berridge, 9 and 10, Pancras Lane.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

National Company for the Distribution of Electricity by Secondary Generators, Limited.—The annual return of this company made up to the 1st inst. was filed on the 14th inst. The nominal capital is £500,000 divided into 3,000 preferred and 47,000 ordinary shares of £10 each. 2,114 preference and £20,000 ordinary shares have been allotted, and the full amount has been called thereon. The calls paid amount to £11,140, and the sum of £210,000 is considered as paid upon 1,000 preferred and 20,000 ordinary shares.

Swan Electric Light Company, Limited.—The annual return of this company made up to the 16th May, 1885, was filed on the 14th inst. The nominal capital is £100,000 in £10 shares. The whole of the shares are allotted, and £37,500 has been received on account of calls; 2,500 shares have been allotted to Mr. Joseph Wilson Swan as fully paid, the paid up capital thus amounting to £62,500.

E. T. Syndicate, Limited.—The registered office of this company is situate at 2, Victoria Mansions, Victoria Street, Westminster.

Fischer Electro Amalgamator Company, Limited.—The registered office of this company is now situate at 15, Queen Street, E.C.

Phosphor Bronze, Co., Limited.—The annual return of this company made up to the 5th ult. was filed on the 11th ult. The nominal capital is £150,000 in £10 shares. 7,491 shares have been allotted, and upon 6,592 shares £10 per share has been called up, and £5 per share upon the remaining 899 shares. The calls paid amount to £70,415.

CITY NOTES, REPORTS, MEETINGS, &c.

Oriental Telephone Company, Limited.

THE sixth ordinary general meeting of this company was held at the Cannon Street Hotel, on Tuesday, under the presidency of Mr. William Addison.

The directors' report stated that the profit and loss account for the year exhibits a credit balance of £3,569 17s. 6d., which shows a slight improvement on the returns of the previous year, in spite of irregularities on the part of the late manager at Mauritius, a loss on the working of the Colombo branch, together with the further heavy fall in the Eastern exchanges. The improvement is in some measure due to reductions in the London expenses. The Indian guarantees are still a very heavy burden on the resources of the company, but full provision has been made for last year's claims in respect thereof in the item of £4,436 3s. 5d. Although the expansion of the Indian revenues has been very slow, and some withdrawals of exchange subscribers have taken place, owing to financial failures and the general depression of trade, on the whole, the results from India are better than last year. The local companies in Bombay and Calcutta are now introducing the "Magneto" system throughout their "exchanges," and it is hoped that with a more efficient service thus provided, a considerable increase in the number of subscribers at each place will follow. From Bombay latterly the advices have been much more encouraging. Your directors have thought it advisable to re-value the stores on hand at the various agencies, and the result is that an amount of £480 16s. 11d. has been written off, chiefly on the value of instruments which had been sent out in the earlier days of the company, and which have been found to be unsuitable. A sum also of £305 7s., 11d. has been charged in respect of the Egyptian indemnity, the £1,000 reserved on this account having proved insufficient to meet the expenses in connection therewith. After writing off all the above items, the balance remaining to the credit of profit and loss is £2,292 10s. 4d., which it is proposed to carry forward. It has been found necessary to make several alterations in regard to the management in the East, and the result has been beneficial. The question of the rights of the company in Australasia has occupied a considerable time in the deliberations of the board, and will continue to engage their serious attention. Your directors are glad to be able to report an increase in the revenues of the subsidiary companies—notably in that of the Egyptian Company—the shares of which are almost entirely held by your company. The Egyptian Company has earned and paid during the past year 5 per cent. on the issued preferred capital. Your directors would point out that these shares, although of the nominal value of £5 each, are only credited in the balance sheet at a value of less than £2 10s. per share. In China the business has been placed on a better footing, and your directors have accepted from the China and Japan Company £4,200 7 per cent mortgage debentures in settlement of the balance due by that company, whose position now shows a distinct improvement. The present board feeling that the Articles of Association, especially as altered from the original form, place undue power in the hands of the directors, have carefully considered the matter and propose certain alterations giving greater influence to the votes of the shareholders, and these proposed alterations will be submitted to an extraordinary general meeting. You will be asked to authorise the payment of the expenses incurred by the committee of investigation, amounting to £72, and whether the said committee shall receive an award for their services.

Mr. A. B. Chalmers, the secretary, having read the notice convening the meeting,

The Chairman said he thought he would be able show that the progress for the past year had been more satisfactory than would appear from a cursory glance at the accounts. The accounts were now in different form, and would be more readily understood Their holdings of shares in different companies were set out in

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a simpler and more intelligible manner, the deferred shares not being included in the valued assets, although as the terms for the guarantees drew near they really became a very valuable property. In the accounts they would see that a sum of £935 was taken credit for last year which really belonged to the year before; it represented the amount of guaranteed interest on the Bengal and Bombay companies' share held by this company in that year. The accounts this time were charged with the item of income-tax, £122, which did not really belong to the year, but to the previous one. Although they were assessed by the Commissioners to the amount of £146 last year, they had, in consequence of their representations that they were not paying a dividend, obtained exemption. In reference to £480 written off for depreciation of stores, half of it hardly belonged to this year, as it was for old material sent out in the early days of the company and which had become practically obsolete. A loss of £350 had occurred on the working at Colombo, and by defalcations in Mauritius; these defalcations were not, however, so serious as was at first expected, and the latest advices led them to hope that £200 would cover the item. Their new agent in Mauritius reported more hopefully of the position generally. Unfortunately their exchanges were in towns which were most particularly affected by the bad times, and the heavy falls in the eastern exchange had largely decreased their profits for the year. During the year the business in Egypt was greatly improved; the directors of the company there had declared a dividend of 5 per cent. as against 3½ per cent. for the previous year. The shares were still valued at less than half their nominal value. Since the accounts for 1885 had been made out the business had steadily continued to improve. The Indian guarantees were gradually decreasing, but not so fast as they wished. The Bengal Company for last year showed a decrease of £650, and the Bombay of £600; the guarantees for the former would expire in May, 1888, and for the latter in September, 1887. After these ceased the deferred shares came in for an equal share with the others, so that instead of having to pay 8 per cent., they would be receiving a per centage on all their holding, whatever it might be. The total number of new subscribers for the year was 537; the withdrawals, caused chiefly by failure and bad times, were 206, leaving a net increase of 331. The total number of subscribers up to December 31st, 1885, were 1,889, as against 1,878 in December, 1884. The total number, up to the latest advices, about the middle of March, was 1,984. The directors had taken £500 for their remuneration for the past year, and proposed to take the same for the current year. They would see that their financial position, with £2,000 deposited at the bankers, nearly £1,000 to current account, and over £600 at their agencies abroad, was by no means unsatisfactory. He moved the adoption of the report and accounts.

Mr. G. A. F. Cavendish Bentinck, M.P., seconded the resolution, which was carried unanimously.

Messrs. Grewing and Lloyd were re-elected directors, and Messrs. Deloitte, Dever and Griffiths were re-appointed auditors.

Mr. A. H. Baker moved that the £72 which the committee of investigation, appointed about two years ago, were out of pocket in consequence of their proceedings, should be refunded, and that a cheque of 200 guineas, or £25 each, should be presented to them for their services in rescuing the company from certain disaster.

Mr. C. L. W. Fitzgerald seconded the motion, and it was agreed to.

This concluded the ordinary meeting; an extraordinary general meeting followed, at which the following resolutions relating to alterations in the articles of association having the effect of limiting the powers hitherto held by the directors were passed:—

1. That article 56 of the articles of association of the company be altered by striking out the words:—" But this article shall be construed as being only directory."

2. That article 60, clause (*a*) be altered by the addition of the following words:—"Provided that the total amount for the time being owing shall not, without the previous consent of a general meeting of the company, exceed £10,000."

To add the following words at the end of amended clause (*c*) of the same article after the words " or other interests ":—" But the authority hereby conferred is not to be deemed to authorise the sale of the entire business or undertaking of the company without the previous consent of a general meeting."

That clause (*d*) in the same article be rescinded and the following substituted:—" They may from time to time appoint any one or more of their number managing director or managing directors, with such share or proportion of the remuneration payable for the time being under article 58, and for such period as they deem fit."

To add the following words to clause (*e*) of the same article:—" Subject to confirmation at the next annual meeting."

To insert in clause (*f*) of the same article, after the words "they may," in the first line, the following words, viz.:—" Subject to the limitations imposed by paragraph (*a*) of this article."

3. That article 61 be altered by the addition of the following words after the words "the continuing directors" in the first line:—" So long as their number for the time being is not less than five."

4. That article 64 be rescinded, and the following be adopted in its place:—" No contract or arrangement entered into by or on behalf of the company with any company, corporation, or partnership, of or in which any director shall be a member or otherwise interested, shall be avoided, nor shall any director being such member, or so interested, be liable to account to the company for any profit realised by any such contract or arrangement by reason only of such director holding such office, or of the fiduciary relation thereby established; but no such director shall vote in respect of any such contract or arrangement."

Reuter's Telegram Company, Limited.

THE twenty-second ordinary general meeting of this company was held at the offices, 24, Old Jewry, on Thursday, when the following report was presented:—

The directors beg to submit the accounts for the year ending 31st December last, which show, after payment of current charges, and deducting rebate on unexpired subscriptions a credit balance of £613 5s. 10d.

In the circular issued last October, the shareholders were informed of the heavy expenses entailed by the successive campaigns in the Soudan and the Anglo-Russian crisis. The anticipations which were then entertained, that the exceptional state of political affairs had ceased were unfortunately not realised, the Servo-Bulgarian and the Burmese wars having followed immediately afterwards.

The directors regret that, owing to these causes, the results of the year's operations do not admit of a dividend being declared. They have, however, the satisfaction to announce to the shareholders that new arrangements have been entered into with the Press, which provide for future exceptional expenditure in time of war or prolonged political disturbance.

The directors regret to have to record the death of their esteemed colleague Mr. James Sydney Stopford. It is not proposed to fill up at present the vacancy thereby created on the board. In conformity with the articles of association, Admiral the Right Hon. Sir John C. D. Hay, Bart, K.C.B., retires from the direction, but offers himself for re-election. The auditors, Messrs. Quilter, Ball & Co., also offer themselves for re-election.

[Our report of the meeting will appear next week.]

The Indo-European Telegraph Company, Limited.

The nineteenth ordinary general meeting of this company was held at the Cannon Street Hotel, on Wednesday, when the following directors' report for 1885 was presented:—The company's revenue from all sources for 1885 amounted to £116,150 3s. 1d. as compared with £98,103 11s. 9d., showing an increase of £18,046 11s. 4d., or rather more than 18 per cent. The expenses were: on commercial and general account, £26,509; on maintenance account, £25,088 8s. 11d., including £145 5s. 11d. paid to the Russian Government; total £51,597 8s. 11d., as against £53,323 19s. 6d., a decrease of £1,726 10s. 7d. This is owing to the exceptional outlay on the duplicate Kertch cable which appeared in last year's accounts. The maintenance expenditure, however, includes the cost of alterations and improvements in the company's lines. On commercial account there is an increase of £1,637 7s. 7d., mainly occasioned by staff for additional through circuits and the expenses attendant upon the increased business done. Deducting the above expenses, taking credit for £4,578 11s. 7d. balance brought over from 1884, and debiting income tax, there remains the sum of £67,456 5s. 1d. From this amount £10,625 has already been paid for interim dividend, leaving a balance of £56,831 5s. 1d. The directors, after setting aside £15,000 to the reserve fund, propose the declaration of a dividend for the last six months of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 30s. per share, both free of income tax, making in all 12 per cent. for the year, and carrying forward £1,456 5s. 1d. to the credit of 1886. The extra cable circuit secured by the new agreement with the Post Office, and the other additions made out of revenue to the company's system, aided by the second wire granted by the German Government, by which two special circuits are secured from London to Teheran, continue to prove of great advantage to the working of the company's system. The above improvements have also contributed to enable the company to deal satisfactorily with the additional business thrown upon the lines during the past year. The large augmentation of revenue is quite exceptional and is owing to the total interruption of the Eastern Company's line for some three weeks, the disturbances in Burmah and the Afghan Frontier question, and it is satisfactory that the £18,046 11s. 4d. of additional revenue has only occasioned an increased expenditure on commercial account of £1,637 7s. 7d. At the Telegraph Conference of Berlin, in response to the desires expressed by the Indian Government and the German Postmaster-General, His Excellency, Dr. von Stephan, it was determined to reduce the rate to India from the 1st of July next from 4s. 7d. to 4s. per word. This will cause a diminution of the company's revenue, but the Board were of opinion that the time had come for a material reduction in the tariff. Reductions were also arranged for, to Australia and China, the amounts of which are not yet fixed, to take effect from the same date. The following directors retire by rotation, and offer themselves for re-election:—Colonel James Holland and H. H. Meier, Esq.

[In consequence of the occurrence of Good Friday this week, we have to go to press a day earlier, and therefore postpone till next week our report of the meeting.]

The Eastern Telegraph Company, Limited.—This Company announces the payment, by interest warrants, on May 1st next of interest for the half-year ending April 30th, 1886, on its 4 per cent. mortgage debenture stock.

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TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 16th were £2,466, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th April are £3,327, as compared with £4,033 in the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending April 16th amounted to £2,964.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

REPLY OF THE PRESIDENT TO THE DISCUSSION ON HIS INAUGURAL ADDRESS ON SELF-INDUCTION.

(*Continued from page* 362.)

IF we reduce the extra currents by employing thin sheets or strips, there is in the case of iron a still more remarkable difference, for in strips of different metals of the same width, the force of the extra currents in iron is actually less than that of brass, and if we compare an iron strip with an iron or copper wire of the same resistance, we have iron wire 500, copper wire 100, and the iron strip 45, or actually 55 per cent. less than the copper wire.

In the case of wires a nearer approach to equality in inductive capacity is shown when they are of the same resistance, but in strips this is reversed, for here, when equality in resistance is produced by wider strips, the difference becomes greater, iron then having actually less inductive capacity than a lead wire of the same resistance.

This extraordinary result must be due, not only to the reactions of contiguous portions of the current being less in sheets or strips than in wires, but also from an imperfect formation of the circular magnetism which takes place in all iron wires on the passage of an electric current. This, however, is only a partial cause, as we can obtain a still further reduction of the extra currents by employing numerous fine wires separated from each other, the circular magnetism in the latter case being perfectly formed in each wire; but we still have the maximum experimental reduction due to the separated portions of the current no longer acting on each other. Copper and all metals show a similar reduction when we separate the wires of a strand conveying a current, but when the numerous wires are brought close together, copper approaches in value that of a solid wire, whilst iron wires are but comparatively little influenced by their closer proximity.

I have tried all forms of conductors, such as square, stellar, tubular, &c.; they all show a gradual diminution of inductive capacity as compared with those of a solid circular section; in a solid conductor the maximum effect being obtained in the circular section, and the minimum in that of a wide flat sheet.

We can reduce the self-induction of any metal far below the comparative force that I have given, by widening the strip or, still better, by diminishing its thickness as we widen it, and it is evident that if we keep the same width and gradually increase its thickness, we then approach the conditions of a solid wire; consequently, where it is necessary that we should be able to utilise a given amount of copper in the best possible form, so as to convey a current of an enormously high tension but of short duration, as required in a lightning rod, we should widen the conductor as much as the mechanical stability and durability of the conductor will allow, and I believe that a lightning conductor of copper 1 mm. thick by 10 cm. wide would satisfy the mechanical requirements whilst preserving the physical conditions necessary for a perfect conductor.

My experiments have shown clearly that a solid iron rod is unsuitable for a lightning conductor; but we may use a stranded iron wire or a flat iron sheet of the same conductivity as the copper. The iron wires should be galvanised, as all iron wires coated with a non-magnetic metal show a marked reduction in their inductive capacity; and here, as well as in the ribbon form of copper conductors, practice has guided our inventors in the right path, for it is an almost universal practice to galvanise iron wires in order to preserve them, and ribbon copper lightning conductors have been gradually replacing the most objectionable iron rod, for which there can be no defence based on experimental or scientific reasoning.

I have already given the results of a compound wire of copper and iron made by myself, but I have since (through the kindness of Mr. W. H. Preece) been furnished with some most admirable specimens of American compound wires, the copper being electro-deposited upon a core of steel wire, and also some specimens in which the core is of copper with a steel exterior. I have thus been enabled, not only to verify my previous results, but to prove that an exterior coating of copper has a most powerful influence in reducing the self-induction of its steel or iron core; for, if we take a given length of this wire and compare it with a similar length and diameter of copper wire, and taking for comparison the copper as a standard of 100, we have only 107, or 7 per cent. increase, for the compound wire, but if we file off the copper so as to leave the steel core bare, the inductive value of this same wire rises to 350.

In order to study this effect, let us place an iron wire in the interior of a closely fitting copper tube, and insulated from it: this has no effect upon the iron wire; but if we join the exterior copper tube to the interior iron wire at both ends, the current passes through both at the same time, and the inductive capacity of this compound system is reduced almost to that of solid copper, as previously observed in the compound wires. These effects can be fully explained, when we reflect that the circular magnetism produced by the passage of an electric current through an iron wire is produced only upon the exterior portion of the wire, and cannot take place when this exterior is, as in a compound wire, of copper; consequently a steel or an iron wire coated with copper of sufficient thickness, is entirely free from this magnetic reaction.

Now, if an exterior coating of copper has such an effect in reducing the self-induction of its iron core, it follows that an opposite effect should be produced by coating a copper wire with iron. Experiments with this, and also with a copper wire inserted in a closely fitting iron gas tube, prove that the effect was as foreseen, viz., a remarkable increase in the inductive capacity of the wire.

One result, however, which I did not foresee, although it is clearly indicated in the experiments quoted in my paper, is that not only is the inductive capacity of the interior copper wire increased to a great degree, but that a copper wire coated with iron has a higher degree of self-induction than a sold iron wire; in fact, its inductive capacity is not only higher than is possible to obtain from the softest iron wire, but its *resistance in the variable period* is proportionally greater than any yet remarked in a solid iron wire. I have made numerous experiments on this subject, and they all show that whilst copper in a straight wire or a single *wide* loop has a far less inductive capacity than iron, it has, on the other hand, the property of being far more excited by the reaction of iron, so that a straight copper wire can be excited by this reaction to a degree greatly exceeding that of a straight iron wire under precisely the same conditions.

I will cite a few experiments which illustrate this point. A copper and an iron wire of equal resistance, and 1 mètre in length, were measured for their inductive capacity and resistance, the inductive capacity of the copper wire being as 100, as compared with 400 for the iron. The resistance of the copper in the variable period had only 8 per cent. increase, compared with 128 per cent. for the iron; but a great change took place when each of these was placed in the interior of an iron gas tube of sufficient diameter to allow of the wire being insulated. The force of the extra currents in the copper wire then increased 350 per cent., whilst the iron increased but 8 per cent.; the force of the extra-currents being now for copper 450, against 433 for the iron.

The influence of an exterior iron tube on the resistance of the wire during the *variable* period was still more marked. The copper wire, which without the exterior iron tube had only 8 per cent. increase, now showed 934 per cent. increase, or, by direct measurement, 1 mètre of this wire, during the rapid rise and fall of the current as in the variable period, had precisely the same resistance as 10·34 mètres in the stable period, or a much greater difference than I have obtained from an iron wire; for the iron wire insulated in the gas tube only showed an increase due to this tube of 22 per cent., giving a total of 178 per cent. difference, or, by direct measurement, 1 mètre of the iron wire with its insulated iron sheath, in the variable period, requiring 2·78 mètres to balance it in the stable period; thus copper shows more than three times the sensibility to an exterior sheath of iron than an iron wire itself. Iron appears to be self-contained, and, as regards self-induction, comparatively less acted on by an exterior influence. This is well shown in the case of coils, where the induction of a coil of insulated iron wire is but slightly increased by its own reactions, or those produced by the introduction of an iron core, as in an electro-magnet, whilst copper coils with an iron core show a remarkable increase. We can thus easily obtain extra currents of ten times the electromotive force of those from an iron coil of the same length, resistance, or diameter; and the resistance of a copper coil, which in the stable period may be far less than that of an iron coil, can, by means of its increased self-induction from the reaction of its iron core, be greater than that of an iron wire coil. At first glance this may be considered unfavourable for copper; but we must remember that whilst copper, in the presence of iron, can be excited to a far higher degree than iron, and consequently has stronger extra currents and greater proportional increased resistance in the variable period, this is really a measure of the work it is capable of doing, for we are able by means of this property to obtain the high efficiency of transformation of energy as in the secondary currents. In point of fact, a dynamo machine having its electro-magnet and armature wound with insulated iron wire would, irrespective of its resistance, have an extremely low efficiency as compared with those wound with copper; and as regards the resistance of either of these wires, there can be no doubt that the resistance of the armature of a dynamo, or, in fact, of any coil of wire as measured during the stable period, gives no approximate indication of what its *real* resistance is during the period in which it is doing work.

The following table shows the influence of an iron tube sur-

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rounding a straight iron or copper wire, compared with compound wires :—

Wires and Iron Tube each 1 metre in length.	Comparative Electromotive Force of the Extra Currents.	Approximate Comparative Increased Resistance during the Variable Period (that of the Stable Period being taken as 1.)
Copper wire, 2 mm. diameter, alone	100	1·08
Same wire insulated in the interior of the iron tube	450	10·34
Same joined to the tube at both ends	275	10·00
Same in contact with the tube throughout its length	200	7·83
Compound wire (copper interior with steel exterior)	325	4·35
Soft Swedish iron, 2 mm. diameter, alone	400	2·28
Same wire insulated in the interior of the iron tube	433	2·78
Same joined to the tube at both ends	240	2·70
Same in contact with the tube throughout its length	215	2·60
Compound wire (steel interior, copper exterior)	107	1·20

The table shows that the iron tube has a much greater effect upon the copper wire than on the iron wire, the effect in both cases being at its maximum when the tube is insulated from its central conducting wire, for when the wire is in contact with its tube there is evidently a shunt action, or species of eddy current, formed between the outer coating and the central portion. This I have been enabled to measure by interposing the telephone between the inner core and the sheath, or still better, by employing a double insulated sheath of iron or copper, and joining them together at one extremity, the opposite ends being joined through the telephone; by this means we are enabled to measure the differential effects of the secondary currents generated in an inner and in an outer sheath.

The table also shows the effect of joining the outer sheath at both extremities, thus allowing a true eddy current to form; this at once reduces the electromotive force of the extra currents, but has but little effect on the differential resistance in the variable period. If, however, we place the wire in contact throughout, so that the effect from the centre to the exterior of each portion can at once be partially neutralised, then there is a marked decrease in its resistance; and if, as in a compound wire, the exterior coating is in direct and still more intimate contact with the inner core, we then have the maximum reduction. We can thus prove that the shunt effect, or partial neutralisation of the extra currents, takes place locally, and probably transversely. We see also, by its effect on the reduction of the resistance during the variable period, that the passage of an electrical current then takes place with less opposing resistance from the self-induction than could be the case if there were no internal partial neutralisation of the extra currents. No doubt this effect also occurs in sheets and strips, and has its influence in causing the remarkable reduction of self-induction that I have already shown.

In conclusion, I once more desire to express my thanks to all who have taken part in the most interesting discussion that has followed the reading of my paper. Mr. W. H. Preece and Prof. Forbes, who have seen my experiments, have borne testimony to the truth and care with which I have carried out these researches; and our well-known American electrician, Mr. Frank L. Pope, has cited examples showing that the superiority of a stranded iron wire was noticed even in the early days of telegraphy, and that the superiority of a compound wire over an ordinary iron wire is a well-known practical fact in the United States. He has also cited a case similar to the experiments of Prof. Guillemin and myself, where an electro-magnet was destroyed by lightning, notwithstanding that the telegraph line was joined direct to earth in advance of the electro-magnet. I am glad that many of the results of my researches are fully borne out by the practical experience of the past; and I hope that those which have as yet not been foreseen in theory or applied in practice will receive the same attention and verification that all discoveries should undergo, as I feel convinced that their truth will become more and more evident when repeated in the laboratory or applied in practice.

Physical Society, March 27th, 1886.

Prof. W. G. Adams, Vice-President, in the Chair.

Mr. A. R. Wright was elected a member of the Society.

The Chairman read a letter from Dr. Alder Wright, Secretary to the "Tribe Fund" Committee, in which reference was made to the scientific work of the late Mr. Alfred Tribe, and an appeal made for funds to aid in the maintenance and education of his family, which, owing to his early death, has been left in straitened circumstances.

The following communications were read :—

"On an Arc Lamp Convenient for Use with the Duboscq Lantern," by Prof. S. P. Thompson. The old Duboscq lamp, though working well with a series of Grove's cells, is very unsuitable for use with currents from dynamos. Prof. Thompson has employed as a substitute in the Duboscq lantern a lamp commonly known as the "Belfast arc lamp." The result is all that can be desired as regards steadiness and regularity. The "focussing," that is, the adjustment of the arc so that it should remain unchanged in position, is effected by a wheel below the lantern, which is moved by hand.

"On a Modified Maxwell's Galvanometer," by Prof. S. P. Thompson. The galvanometer consists of a light frame of copper upon which is a coil of wire. This is suspended between the poles of a horseshoe magnet, and a piece of soft iron is placed within the coil but free from it, which concentrates the magnetic force between the poles. The coil is suspended by two silver wires, by which it is in connection with two binding screws on the base of the instrument. This galvanometer is extremely simple in adjustment and very dead beat, it has also the advantage of being affected to an inappreciable extent by neighbouring magnets and currents, with a current in its own coils; when no current is in it, it is, of course, quite unaffected. The reading is effected by the ordinary lamp, mirror, and scale arrangement.

"On the Expansion of Mercury between 0° and − 39° C. by Profs. W. E. Ayrton and John Perry. On November 14th, 1885, Mr. G. M. Whipple gave the Society the results of the examination of thermometers down to the melting point of mercury. There was, however, no evidence as to whether the contraction of the mercury continued uniform, as the thermometers were only compared with mercurial ones. The authors have therefore examined this point and have made a series of comparisons of a mercurial thermometer, lent them by Mr. Whipple, with a constant volume air thermometer, both immersed in a bath of frozen mercury which was allowed to gradually become warm. The result obtained was that no certain deviation from a linear law could be detected in the expansion of mercury when temperature was measured by the increase of pressure required to keep a volume of air constant. Hence temperatures down to − 39° C. may be correctly measured by a mercury thermometer the stem of which is graduated for equal volumes.

"On the Expansion produced by Amalgamation," by Profs. W. E. Ayrton and John Perry. It has been accidentally observed by the authors that the amalgamation of brass is accompanied by great expansive force. If one edge of a straight thick brass bar be amalgamated, it will be found that in a short time the bar is curved, the amalgamated edge being always convex, and the opposite concave. The authors imagine that a similar action may be the primary cause of the phenomena presented by the Japanese "magic mirrors." Japanese mirrors are made of bronze and have a pattern cast upon the back, and although to the eye no trace of it can be discovered upon the polished reflecting surface, yet, when light is reflected by certain of these mirrors on to a screen, the pattern is distinctly visible in the luminous patch formed. In a paper before the Royal Society they have shown that this is due to the polished side opposite the thinner parts of the casting being more convex than the others, a conclusion verified by the fact that the pattern is reversed when formed by a convergent beam of light. Such a condition of things would evidently result from an uniform expansive stress taking place over the reflecting surface, the thinner, and consequently the weaker, parts becoming more convex or less concave than the others. The authors have hitherto attributed this inequality of curvature to a mechanical distortion to which the mirrors are intentionally submitted during manufacture, to produce the general convexity of the polished surface, but they now think it possible that the use of a mercury amalgam in the process of polishing may have an effect in the production of this inequality of curvature.

April 10th, 1886.

Prof. Balfour Stewart, President, in the Chair.

The following communications were read :—

"On the Cause of the Solar Diurnal Variations of Terrestrial Magnetism," by Prof. Balfour Stewart, L.L.D., F.R.S. The author commenced by reviewing various theories that have been advanced to account for the solar diurnal inequalities of terrestrial magnetism. That they can be due to the direct magnetic action of the sun is highly improbable, since terrestrial analogies would lead us to infer that matter at the temperature of the sun is quite incapable of possessing magnetic properties, and also from the fact that changes in the range of the daily variation lag behind corresponding solar changes in point of time. The hypothesis of Faraday, that the observed variations are the result of the displacement of the magnetic lines of force due to the varying temperature, and consequently varying magnetic permeability of the atmospheric oxygen, is disproved by the fact that there is no agreement between the chief magnetic variations and those of the temperature of the great mass of the atmosphere, though it is certain that there must be some effect due to this. The earth-current hypothesis is quite unable to explain one of the chief characteristics of these variations, that they are half as great again at periods of maximum as at those of minimum sun-spot frequency; Sir George Airy has, moreover, been unable to detect any resemblance in form between the regular diurnal progress of the magnet and that of earth currents. We seem, therefore, compelled to seek for the cause of the variations in the upper

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atmospheric regions, and we cannot imagine such a cause to exist in any other form than that of a system of electrical currents. That currents may, and actually do, exist at great heights is shown by the Aurora, which is unquestionably an electric current and manifests a close connection with the phenomena of terrestrial magnetism. The great increase of magnetic variation at epochs of maximum sun-spot frequency can also be accounted for on this supposition. Prof. Stokes has remarked that an increase in the radiating power of the sun would probably imply, not only an increase in general radiation, but a special and predominant increase in such actinic rays as are probably absorbed in the upper regions of the earth's atmosphere. These regions will, therefore, greedily absorb the new rays, their temperature will rise, and, as is known to be the case for gases, the electrical conductivity will be increased. Thus, even if we imagine the general atmospheric current to remain constant, a greater proportion of it would be thrown at such times into those heated portions which had become good conductors, but it is also probable that the current itself would be increased. Assuming the existence of currents at great altitudes, the regularity and general characteristics of the diurnal variations would seem to point to a direct magnetic action of the currents, rather than to any general induced change in the magnetic system of the earth, which, to produce the observed results, would have to be of a very artificial character. The diurnal variation of the declination, attaining a westerly maximum at 2 p.m., north of the equator, and an easterly maximum at the same time south of it, would suggest the existence of currents flowing northward and southward from the equator to the poles, attaining a maximum in each hemisphere about two hours after the sun had passed the meridian. To supply this flow we should probably have to assume the existence of vertical currents ascending from the equatorial regions of the earth. At this point Dr. Schuster had endeavoured to apply mathematical analysis to the subject. From the recorded observations at Greenwich, Lisbon, Hobarton, St. Helena, and the Cape, he has shown that the work done by a magnetic pole describing a closed path in a horizontal plane at those places is equal to the work done upon it, and consequently no part of the ascending current can be enclosed by the path. Hence the potential at those places obeys the law expressed by the equation

$$\frac{d^2 v}{d x^2} + \frac{d^2 v}{d y^2} + \frac{d^2 v}{d z^2} = 0.$$

From this, Dr. Schuster has deduced two possible expressions for the potential, one referring to a system of currents above our heads, and the other to one beneath our feet. From the first of these expressions it follows that for latitudes greater than 45°, the maximum of horizontal force should coincide with the minimum of vertical force, and *vice versa*, and this is actually the case at Greenwich: while the opposite should hold if the influencing system were beneath us. For latitudes below 45° the reverse of the above should be the case, and the observations at Bombay, though less decided than those at Greenwich, would seem to point the same way. On the whole, then, it must be said that the results of the first attempt are very encouraging, and point to the supposition that the greater part of the disturbing cause lies outside the earth's surface.

In a discussion that followed, Mr. Whipple remarked that recent observations in high latitudes seem to show that the Aurora is not always at such a great height as is usually supposed. Prof. A. W. Rücker cited the well-known case when an observer saw what appeared to be a meteor fall into the sun, while simultaneously, or nearly so, there was recorded a magnetic disturbance on the earth, as showing a direct solar action. Mr. Whipple, however, stated that he had recently examined this point, and believed that the very slight notch in the record, many similar to which have occurred since, was of an accidental nature, and a mere coincidence.

Prof. McLeod suggested that the earth-current theory might be tested by observations at the bottom of a mine, where, according to the theory, the disturbances should be reversed.

Prof. Adams believed that there was nothing physically imimpossible in the existence of such currents as the author imagined.

"On a Relation between the Critical Temperatures of Bodies, and their Thermal Expansions as Liquids," by Prof. A. W. Rucker, F.R.S., and Prof. T. E. Thorpe, Ph.D., F.R.S. A paper by the authors bearing the above title was published in the *Journal of the Chemical Society* of London for April, 1884. The substance of the paper was as follows: Prof. Mendelejeff has shown that the expansion of liquids under constant pressure between 0° C. and their boiling points may be expressed by means of the very simple formula

$$v_t = \frac{1}{1 - k\,t.}$$

v_t being the volume at t.° C. (that at 0° being unity) and k a quantity which differs for different substances but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling point. From this law the authors have obtained as a deduction the following expression for the critical temperature (T_c) of any liquid

$$T_c = \frac{T\,v_t - 273}{a\,(v_t - 1)}$$

where v_t is the volume at t.° C., T the absolute temperature, and a a quantity which is very nearly constant for all substances, and which was shown to be very nearly 2.

In a recent paper (*Ann. Ch. Ph.*, March, 1886,) MM. A. Bartoli and E. Stracciati have discussed both of these formulæ, and have applied them to cases in a manner never intended by the authors. They have expanded Mendelejeff's formula into the series

$$v_t = 1 + k\,t + k^2 t^2 + k^3 t^3 \ldots\ldots$$

which is a geometrical progression, and they have objected that the results of Pieire, Kopp, Hirn, Thorpe, &c., do not give for the coefficients of t, t^2, t^3, quantities in geometrical progression. The results of these observers are given in the usual form

$$v_t = 1 + a\,t + b\,t^2 + c\,t^3 + \ldots$$

but owing to unavoidable errors of experiment the constants c, d, of different observers differ very largely, and Mendelejeff's simple expression gives the results of all quite as accurately as the facts will allow. MM. Bartoli and Stracciati have then criticised the expression given by the authors, and have applied it to determine the critical temperature of water from its expansion to 200° C., whereas the original expression is only given as applicable as far as the boiling point. They have further recorded a number of critical temperatures calculated by the formula to tenths of a degree, for which the constant a would require to be known to ·025 per cent., whereas there is no reason for supposing it known to within one per cent., or more.

NEW PATENTS—1886.

5168. "Electric lighting of trains." R. E. B. Crompton, J. Swinburne. Dated April 14.

5176. "Dynamo-electric and electro-dynamic machines." C. L. Baker. Dated April 14.

5215. "Electrical batteries." A. Campbell. Dated April 14.

5218. "Electrometer." B. Pell. Dated April 14.

5223. "Insulating materials for electrical purposes." P. Ward, S. J. Blane, Bart. Dated April 14.

5242. "Electric arc lamp." J. L. Balbi, F. Tolley. Dated April 15.

5250. "Couplings and fastenings for coupling the ends of ropes containing an insulated wire and for securing the ends of such ropes to grapnels." H. Kingsford. (Communicated by S. Trott and F. A. Hamilton.) Dated April 15. (*Complete.*)

5273. "Arrangement for mounting and driving dynamo-electric machines." H. P. Holt. Dated April 15. (*Complete.*)

5276. "Telephonic apparatus." E. Berliner. Dated April 15. (*Complete.*)

5298. "Secondary voltaic battery." C. Moseley. Dated April 16.

5338. "Governing dynamo and other machines" W. T. Goolden, A. P. Trotter, H. W. Ravenshaw. Dated April 16.

5341. "Mechanical telephones." E. P. Alexander. (Communicated by H. Lamont.) Dated April 16.

5381. "Electrical contact apparatus." A. de Khotinsky. Dated April 17.

5409. "Dynamo machines." L. Bollman. Dated April 19.

5437. "Electric arc light." A. N. J. Contarini, N. Contopoulos. Dated April 19.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3525. "Improvements in apparatus for distributing and utilising electricity." R. P. Sellon and J. S. Sellon. Dated March 18. 8d. The object of the invention is to provide means whereby a current of high tension may readily and simply be converted into one of low tension, without the necessity of employing secondary batteries or other intermediate converting appliances, for attaining this end, and means for regulating the speed of motors, so that a constant or any desired ratio of difference in speed may be maintained of the motors, whether they are doing useful work or merely running idle. The inventors employ a dynamo-electric or electro-dynamic machine, of which the revolving armature is wound with two distinct and independent sets of coils, each set of coils being carried to a separate commutator or collector. The iron of the field magnets of this armature is common to both sets of coils of the armature, but the field magnets have coils so arranged that a portion is in connection with the first set of coils upon the armature and a portion is in connection with the second set of coils upon the armature. By this arrangement they obtain what may be called a "motor generator" inasmuch as the passage of a current through one set of coils upon field magnets and its corresponding armature coils will cause a revolution of the armature to take place, the speed of such revolution being mainly dependent on the intensity of the magnetic field in which it revolves. This revolution will cause the second set of coils upon the armature to be likewise drawn through a magnetic field, and thus a current will be set up in the coils of the second portion of the armature, which may be used for any purpose, for example lighting or heating.

4506. "Improvements in telegraphs." C. Langdon-Davies. Dated April 11. 8d. According to this invention telegraphic signals are transmitted by means of induction coils furnished

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with vibrators, and in conjunction with electrophones in such a manner as to permit of one or more electrophonic transmissions simultaneously with the ordinary telegraphs.

4541. "Improvements in electric telephony." J. G. LORRAIN. Dated April 13. 6d. Consists in employing as charging batteries for the transmitting and receiving instruments a series of secondary couples or accumulators, arranged so that they can be themselves charged in quantity by a primary battery, or other source of electricity, and then when required they can be arranged in series for charging the transmitters or receivers.

4688. "Improved carrier or support for incandescent lamp shades." A. SWAN. Dated April 16. 6d. Three arms made of thin hammered brass (or other suitable material) radiate from a common centre, and are so shaped and bent, as to form a spring; each arm of the spring at its termination being turned down and inwards, so as to form a claw. A loose ring, forced over the spring, presses the arms together, and this has the effect of closing the claws upon the projecting flange of the shade, and so supporting it. The "eyelet," or disc, from which the arms of the spring radiate, is furnished with a tapped ferrule, to any required size to suit either a nozzle for flexible cord, or for coupling on to a fixed electrolier.

4771. "Improvement in wiring interiors for electric light and other purposes, and in devices and tools therefore." B. J. B. MILLS. (Communicated from abroad by L. Stieringer and J. H. Vail, both of New York.) Dated April 17. 8d. Consists in the use of staples or hooks of insulating material, which are inserted into the supporting woodwork of the structure, or a wood moulding or other suitable insulating backing supplied for the purpose.

4854. "Holder for incandescent lamps." H. PIEPER. Dated April 20. 8d. Consists of two main parts, a plug made of insulating material and a metallic spiral. The plug, which is designed to be attached to the arm or bracket carrying the lamp, is provided on the upper part of its side with a small binding post, to which is connected one of the conducting wires, while the other conducting wire is carried to a screw centrally inserted into the bottom of the plug. The spiral, made of thick wire, constitutes a kind of nut adapted to be screwed with one end on screw threads formed on the lower portion of the plug, and with its other end on the base of the lamp, also provided with corresponding screw threads, a connection between the plug and the lamp being thus produced.

4963. "Improvements in couplings for an electric circuit in connection with the brake pipes of railway trains." W. E. LANGDON. Dated April 22. 8d. To a block of ebonite, or any other insulating material, the inventor affixes two pieces of metal, or fangs, insulated at that part at which they are attached to the ebonite, the one from the other. One of these fangs he makes rigid, the other consists of a spring so constructed that the end opposite to that at which it is fixed to the ebonite shall make contact with the rigid piece of metal, or fang, previously referred to. The inside of this rigid fang he insulates, leaving uninsulated only such space at the extreme end, as is required to enable the spring fang to form metallic contact with it when at rest, that is, when the coupling is disconnected or uncoupled. The space between the two fangs is regulated by the thickness of the rigid fang. The block of ebonite carrying the said fangs, he fixes in a hood, or cover, and having attached the necessary wires by which the electrical communication is carried through each coach or other vehicle, a hood with its contents is firmly fixed upon each portion of the brake coupling in such a manner, and in such a position, that when the two portions of the brake coupling are connected up, the fangs upon the one portion shall engage with the fangs upon the other portion, and this, so that the spring fang of the one, shall form contact with the rigid fang of the other, and that when thus thrust together, the spring fang shall be forced apart from the rigid fang of its portion of the coupling which in its normal condition it maintains, and the two wires forming the communication attached to each portion of the coupling shall become respectively connected with each other.

5202. "Improvements in galvanic batteries." A. SCHANSCHIEFF. Dated April 27. 4d. The inventor applies directly on to the positive plates of batteries an exterior coating of collodion albumen gelatine, gluten, or such like substance to protect their surface from the direct action of the liquid in which they are immersed, and so avoid local action and render the battery current constant.

CORRESPONDENCE.

Secondary Generators or Transformers.

IN your issue of the 9th inst., wherein you publish the letter in which we claim absolutely the exclusive right to use secondary generators or transformers for the distribution of electrical energy of variable quantity and potential according to the requirements of each individual consumer, you state that the publicity given by you in 1883 to the anterior work of Sir Charles Bright, Messrs. Jablochkoff, Fuller, and others shows the absurdity of our present claim.

In arriving at this conclusion you have evidently forgotten that you cited these anterior experiments to prove the uselessness of the researches that we were making at that time, all the attempts mentioned having remained without any industrial result, owing to the insufficiency of the return obtained by these experimentalists whose value as scientists was much greater than ours.

Sir Charles Bright himself declared, at the meeting of the *Societé Internationale des Electriciens*, at Paris, in February, 1884, that the experiments made by him in 1878 for arriving at the same results as ourselves, and by similar means, only led him to establish a loss of 50 per cent. We have, then, the right to claim that our trial installation on the Metropolitan Railway was unprecedented; it consisted of the distribution, at five of the stations, by means of a circuit 15 miles long and 3 mm. in diameter, of electrical energy in the different forms required for feeding the various apparatus employed there; this fact constitutes a new and consequently patentable industrial result.

It is equally incontestible that in 1884, at the Turin International Exhibition, we positively for the first time transported and distributed over a circuit 82 kilometres long and 3·7 mm. in diameter, electrical work of 50 H.P.; this electrical energy was employed at five different points for lighting all known kinds of electrical lamps.

The industrial development which our system of distribution has now attained renders it impossible to deny that we have been the first to indicate the conditions for the construction of induction apparatus capable of giving a transformation return of 95 per cent.

We therefore rely upon successfully defending in the Courts of Law our patents, which comprise: "A new system of distributing electricity over great distances, and of transforming this energy at an unlimited number of points on one and the same circuit into electrical currents absolutely independent of one another and of every kind, that is, suitable for all purposes such as arc and incandescent lighting, motive power, electro-chemical processes, &c."

You will observe that the great problem of the distribution of electrical energy had never been before defined with precision, and the results which we have obtained are there to prove that our claims are not based upon ideas that can be called Utopian or absurd.

L. Gaulard.
J. Dixon Gibbs.

London, *April* 16*th*, 1886.

[Messrs. Gaulard and Gibbs misunderstand us. We do not, for one moment, disparage the work done and the results obtained by our correspondents; indeed, whatever may be the ultimate fate of their apparatus, they deserve to achieve success. We again say, however, that these gentlemen were ill-advised in claiming transformers of *any model* for the purpose of distributing electrical energy. Do they include those very models of Bright, Jablochkoff, Fuller, and others, which they admit to be anterior to their own specifications? Because the Willans' engine, as shown in the report on the Crompton dynamo in our last week's issue, is more economical than such motors have been thought hitherto, Messrs. Willans and Robinson might, with as much show of reason, claim any model of high-speed direct-driving engine. Messrs. Gaulard and Gibbs are, doubtless, entitled to the sole right of the mechanical construction as adopted in their induction coils, but other people have an equal right to employ different methods of manufacture, the *principle* being free to all.—EDS. ELEC. REV.]

Measuring Intermittent or Alternating Currents.

In your issue of 9th inst. is a communication from Profs. Ayrton and Perry, in which certain experiments of Captain Cardew's are mentioned. Now isn't it

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begging the question to suppose that the Siemens dynamometer, or any such instrument, measures the mean square of an intermittent or alternating current? I have a faint recollection of an investigation of Prof. Mascart's (?) into this question, in some paper of his on alternate currents, which were measured by a Thomson electrometer with needle connected to one pair of quadrants; but I can specifically refer you to a paper by Hospitalier in *L'Eléctricien*, vol. viii., p. 289, on this subject.

I should recommend experimenters when they ask for mean squares to see that they get them.

F. J.

April 17th, 1886.

Professor Hughes and Self-Induction.

In my letter to you of the 12th inst., published in No. 438 of your journal, I enumerated several novel propositions which Professor Hughes has given for the guidance of the practical electrician.

Now, if I rightly understand the professor's meaning, it follows that if two circuits, one of iron and the other of copper, but both of the same resistance, as determined by the "stable" method, were employed to carry rapid currents, the strength of the working current would be very much less through the iron than through the copper. My experiments were made with a view to test the correctness or not of such a statement. The results I have obtained certainly do not agree with those given by Professor Hughes; for I find it to be practically immaterial of what metal or form the conductor is, providing the resistance is precisely the same. That is to say, Ohm's well-known law, as far as I can judge by the light of my own experiments, appears to be practically correct for "variable" as well as for "stable" currents.

I should not have written you again on this subject had not you, in your comment on my letter, called in question the suitableness of a galvanometer for such an experiment as I explained in that letter.

My object was to ascertain the strength of the working current under variable conditions of the conductor, bearing in mind always to keep the resistance the same. Now I found the galvanometer a most suitable instrument for my purpose, for, when the resistance of the circuit was intentionally altered, it proved very susceptible to the slightest change. When a telephone was substituted for the galvanometer, it appeared, as far as the ear could judge, to be affected the same as the galvanometer. In the case of using reversals, if the connections of the galvanometer be reversed at the same time as those of the battery, a steady deflection would be obtained which would represent the true strength of the working current. I am referring to a mirror reflecting galvanometer, the divisions on the scale of which are, for all practical purposes, directly proportional to the strength of the current. Of course, theoretically, the speed of the interrupter, or reverser, might be such that the galvanometer would be apparently unaffected, while a telephone would be still audibly affected; but that proves nothing more than that the telephone is the more sensitive instrument of the two in an experiment of that kind.

My belief is that, in dynamic electricity, polarisation precedes conduction, in fact that conduction is the result of polarisation, and that there can be no conduction without polarisation; consequently, before an electric current can be produced in matter of any description, size, or form, the atoms composing such matter must all have become polarised by induction. If this be so, it follows that, when a battery or other source of electrical power is applied to a conductor, a certain period of time must elapse before the strength of the current flowing in the conductor reaches its maximum; this period of time is the "variable" or polarisation period, and is that period in which all the phenomena examined by Prof. Hughes takes place, therefore it is most important to know, with some degree of accuracy, its duration, for thereon depends the *practical* importance of the subject in its relation to telegraphy, &c., that is to say, if the duration is so brief as to be infinitesimal, then its practical importance is equally small. It is during this period that the resistance of an iron wire, as measured by Professor Hughes, is stated to be more than three times that of copper.

In my arrangement, a complete circuit was made up of a galvanometer, rapid interrupter, battery and wire under test, the interruptions were exceedingly rapid (about 200 per second), and the probable period of contact during which the circuit was closed must have been less than the $\frac{1}{500}$th part of a second. That being the case, it is clear that, if the "variable" period lasted for the $\frac{1}{500}$th part of a second, then the galvanometer would only be in circuit during the "variable" period, and the deflection would consequently represent the current flowing in the "variable" period alone, and, since the current flowing depends upon the resistance of the circuit, the deflection would indicate the *resistance* in the "variable" period. Now, by this method, an iron wire and a copper wire can be directly compared, and since they have been compared by actual experiment and found to produce practically equal deflections, it follows that either the "variable" period is equal in both cases, or else that the duration of that period is so exceedingly small that, although the circuit is only closed for the $\frac{1}{500}$th part of a second, yet that brief period is sufficiently long to embrace not only the "variable" but also the "stable" period; and, further, that the "variable" period forms so small a part of the $\frac{1}{500}$th part of a second, that the test, although of so brief a duration, is practically a test of the "stable" period. It must be clearly understood that each contact forms an independent test, the galvanometer deflection representing the result of many of these tests superimposed one upon the other.

No doubt the duration of the "variable" period depends upon the work the polarisation has to do; and since, owing to the magnetic properties of iron, polarisation in that metal is called upon to perform a greater amount of work than in other metals, it is quite understandable that, theoretically, the "variable" period for that metal may be of greater duration than with non-magnetic metals. But what I doubt is, whether it is of such practical importance as Prof. Hughes supposes it to be. The question is one of great importance in telegraph systems, especially where high-speed instruments are worked, and I have no doubt but that long ere this it has been practically tested by practical men. If that be so, perhaps those gentlemen will publish the results of their experience; and, should they confirm the view of Prof. Hughes, that gentleman will have again rendered very valuable service in the advancement of our electrical knowledge.

Willoughby Smith.

April 20th.

Incandescent Lamps.

In your report of the adjourned discussion on Mr. Bernstein's paper, an error has crept in.

In my remarks I pointed out that lamps worked on the series system must of necessity have shorter lives than if worked on the parallel system. This fact is quite independent of the character of the lamps. In his reply you make Mr. Bernstein say that my statement "is not correct if the carbons were of proper quality." Mr. Bernstein did not say this. He did not question the accuracy of my statement.

As you last week devoted a leading article to the important subject of life of lamps, this cardinal difference between the effect of constant current and constant potential difference working may be of interest to your readers, and I am anxious that no misapprehension should exist on the point. Perhaps, in justice both to Mr. Bernstein and myself, you may think it worth while to put the matter right.

A. M. Mordey.

April 19th, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 440.

DYNAMO TESTS.

A FORTNIGHT ago we pointed out several discrepancies between the indicated and electrical horse-powers as obtained from a Willans high speed engine driving direct a Crompton dynamo, and in reply to our remarks we publish in our Correspondence columns to-day a letter from Messrs. R. E. Crompton & Co., which is intended to be explanatory of the results we criticised. The discrepancies are said to be due to the difficulties of keeping up the steam pressure in boilers too small for their work and in taking indicator diagrams simultaneously with electrical observations, it being further stated that the main question as regards fuel consumption per E.H.P. remains unaffected by the existence of such discrepancies.

In our previous article we accepted the efficiencies as published in the report and requested to know the cause of the variations, but our correspondents ask us to change our ground somewhat. Now we are told that due to the want of simultaneity between the taking of the diagrams and the electrical observations the efficiencies given may be incorrect, and that while great care was taken to get simultaneous readings, in some cases the indicator cards were taken a few seconds later than the electrical readings. We fully appreciate the difficulties of the test, but we do not see how the above circumstances could account for such great variations if ordinary care had been adopted in the signalling. Moreover, the errors due to this cause might have been practically eliminated if the test had been conducted with due regard to the steaming capacity of the boilers.

One of the main objects of the test was to ascertain what percentage of I.H.P. in the engine cylinders could be obtained as useful E.H.P. at the terminals of the dynamo, and we consider, therefore, that one of the main questions is at issue here. Admitting that the boilers were too small for the maximum load put on them, it would have been easy to work for two hours with constancy had the load been somewhat smaller, and it does not agree with our ideas of testing to work under circumstances which entail excessive periodic fluctuations when under a proper adjustment of the electrical output to the steaming capacity of the boilers such prejudicial effects could be avoided. With foresight, the first two hours' run would have enabled the experimenters to determine what electrical output could be maintained with constancy; and it would have been far more satisfactory if, instead of working by fits and starts, the experiments had been conducted after this method. With the lowest I.H.P., namely, 101·57, the efficiency is said to be 75·7 per cent.; so that with less load there would have been, if this figure is correct, a clear gain in efficiency. There is no load so easy to manage as an electrical one, which can be adjusted with the utmost nicety; and when we have to deal with boilers which err on the side of insufficiency, the errors due to this cause should be eliminated as far as possible by reducing the load to a point which can be maintained with constancy throughout the trial. When this is done, errors due to the lapse of a few seconds between the taking of the diagrams and the noting of the electrical observations are practically unimportant; and discrepancies such as those indicated would be impossible unless the efficiency actually varied, as we have before suggested, due to variations in the internal engine friction. As the figures stand, we are in a somewhat worse plight than when penning our former remarks, as we are now uncertain whether the efficiencies given are true or false. We think, however, that with a view to avoiding errors in future tests, our remarks on the subject will be found worthy of consideration.

If we reject, as suggested, all the efficiency tests and consider merely the water consumption per E.H.P., the result is a good one; but we have heard since publishing our previous notice that an efficiency of over 70 per cent. has been obtained by other makers from belt driving, the power being transmitted through counter shafting. Without saying anything about the interests of students being served by the publication of Messrs. Crompton's tests, we can at least aver that they have in these results abundant food for thought.

In conclusion, we may call attention to an error in the diagram which shows the I.H.P. and E.H.P. developed during the run. Owing to some mistake on the part of those who furnished us with the drawing, the readings of I.H.P. from 7 : 5 onwards are plotted twenty horse-power too high.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XVII.

TELPHERAGE is another branch of electric locomotion which is destined to play an important part in industrial undertakings where minerals and goods of every description have to be conveyed to distant places, over fields or mountains and across rivers, where railways, roads and bridges are scarce. This system is intended to supply a want in countries where the resources of a fruitful soil lie dormant, because the cost of conveyance of crops or minerals to the distant railway or harbour, is rendered too great on account of the absence of convenient roads and bridges, and the amount of traffic is not sufficient to warrant the expenditure of a large capital. Telpher lines are not to supplant railways, but to serve as feeders of such. It is claimed that this system offers advantages over the teledynamic transmission (rope gearing) where considerable distances have to be traversed, and especially where many curves or corners occur on the route.

The first telpher line was erected and shown at Weston on the estate of Mr. Prior and a larger and more complete line has been in operation at Glynde, in Sussex, since October, 1885. This system has been so recently and so fully described by Prof. John Perry in

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his admirable lectures at the London Institution, that it would be difficult to add anything or suggest uses to which it may be adapted other than those already thought out by Prof. Perry and his energetic colleagues. Those who have attended the lectures referred to, or who have read the same and studied the illustrations, must have been struck with the number and variety of ingenious details; an immense amount of thought has been bestowed upon telpherage, and there is no doubt that the instances where this system can be advantageously applied are numerous. The doubts and fears which have been entertained by many as regards the economy of electricity when applied as a medium of transmission of power are gradually disappearing. Almost daily new facts are brought forward which supply the desired proofs, and sceptics are rapidly being converted into firm believers. The commercial efficiencies of dynamos and motors, it has been shown, are such as to render electrical transmission one of the most economical and most reliable, and the time is drawing nearer when this form of energy has to be taken into serious consideration, when questions as to the best or the most convenient mode of transmission of power have to be solved; this aid to engineering solution has come upon us with rapid strides and we are almost anxious, lest engineers in general may not be prepared to fully appreciate the progress made in this branch of engineering. The efficiency of any system can be calculated with absolute certainty and the cost of installations is easily ascertained. Advocates of particular systems occupy themselves seriously with the task of perfecting small details, whilst the general principles are supposed to be well understood; this is a healthy sign, for it is upon the care and attention given to mechanical details, the material and workmanship, that the continued success of any system will depend. The question of the cost of the source of energy may be considered as settled, and it depends solely upon points of convenience, maintenance, and the depreciation as to whether one system will gain ascendancy over another.

Passing on from electric tramways and telpherage we will next devote a few words to another branch of electrical engineering, perhaps not as important but equally interesting, that is electrical navigation—an imposing title, which reminds one of steam navigation, and of enormous ocean ships and even torpedo boats steaming at 24 knots an hour. The claims of electricity as a motive power for the propulsion of boats are, however, still very modest. Nothing "big" has as yet been attempted, and is not likely to be attempted for some time to come, unless discoveries of an extraordinary nature are made.

There is no hope, as yet, that ocean ships will be electrically propelled from port to port; large marine engines are exceedingly economical in fuel, and the present methods of storing electric energy cannot supersede the carriage of fuel as regards weight or space; and we must be contented with the application of electricity to the propulsion of launches, be satisfied with moderate speeds and voyages lasting hours, but not days or weeks, without replenishing the expended energy. Assuming that one horse-power (effective) can be obtained for one hour with 150 lbs. weight of secondary batteries and motor, then we should require, for a supply of 24 hours' continuous run, 1·6 tons of propelling apparatus; this weight can only be carried by a boat of certain minimum dimensions, because 1·6 tons represents a displacement of nearly 58 cubic feet of water; adding to this the displacement caused by the weight of the hull itself, we get some 70 cubic feet, and this will involve a boat of about 25 ft. length, 5 ft. beam, and 18 inches mean draught of water. It is doubtful whether one horse-power (effective) will give a speed of four miles an hour to such a vessel. But the said weight of apparatus, when rationally arranged, will give a speed of about seven miles an hour in still water to a 25 ft. launch, if we use the energy at the rate of four horse-power, and run for six hours only; but at the slow speed we may be able to travel 96 miles, whereas at the rate of seven miles an hour the stored energy will carry us a distance of 42 miles only with one charge. This result will be regarded as quite sufficient for the purposes of pleasure launches or tenders attached to large steam vessels. If charging stations were provided at suitable distances apart on our navigable rivers, then it would be an easy matter to replenish the energy at intervals, and pleasure trips of any length could then be made on electric boats.

As an auxiliary power to small sailing yachts, electricity should find extensive application. The apparatus can easily be stowed under the floor, and the whole of the boat would be left clear without in any way detracting from the beauty of the sailing boat; such apparatus would serve as the ballast, which ballast can be made use of during a calm, or at any moment when the convenience of a motive power, other than wind or tide, may be desirable. When not in use, the energy stored in accumulators remains unimpaired for many weeks, and is always in readiness; this latter advantage will be found of great use.

Absence of smoke, of heat, of noise, and the ease with which electric launches can be handled by anyone, render these peculiarly adapted for pleasure purposes. Attached to men-of-war ships, in harbour duties, electric launches will be found of great convenience. Police boats should all be propelled by electricity; and this subtle force is now successfully applied to submarine boats and to the propulsion of navigable balloons.

The author has treated this subject of electric launches on so many occasions, notably, in communications to the ELECTRICAL REVIEW in December, 1882; the British Association, 1883; the Society of Arts, 1884; that any further remarks are unnecessary, unless they refer to recent improvements in details of construction, and practical examples will be described at an early date.

AN IMPROVED METHOD OF CABLE WORKING.

By J. EBEL.

WHEN the length of time that has elapsed since the discovery that telegraphy was possible over long ocean cables is taken into consideration, one is forced to the conclusion that very little advance has been made in the systems of practically working such cables.

It is very probable, however, that many electricians have arrived at some method of improved working which, for some reason or other, they have not made known, and, in reflecting on the small progress that has been made in this particular branch of electrical science, regard should be had to the fact that it is very difficult for students and inventors to obtain access to the cables themselves to test theories by experiments. It is very likely, in a great measure, due to the want of such facilities that some improved systems of working have not long ago been devised.

On searching through some back numbers of this journal, I find, in the issue of Dec. 26th, 1885 (page 357), an article on duplex cable working, which induces me to submit a system which, I venture to think, may be found a further advance in the same direction, feeling fully satisfied, after careful experiments, of its practical application.

No doubt, much credit is due to Mr. Muirhead for having brought into use a simplified system, but there does not appear to be anything particularly new in the diagrams illustrating the article in question, and some years back, in the course of some experiments on working duplex, I made use of two condensers connected in the same manner as shown in the diagram referred to, where I proved the bridge wire to be superfluous. I was not aware at that time that this idea was already known. (See Provisional Patent Specification, 1879, No. 5119.)

The accompanying diagrams illustrate the result of my own investigations.

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For working the duplex system where the bridge wire (sometimes called the fork) can be dispensed with, I maintain that the employment of a receiving instrument, with differentially wound coils, is preferable to the ordinary instrument.

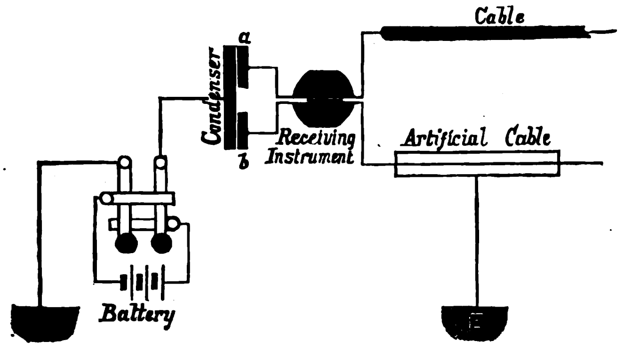

FIG. 1.

In fig. 1, a condenser is connected up, having three plates, or an equivalent thereto, two condensers with one plate of each joined. In this case, the middle plate is charged by the sending current, and the opposed *a*, *b*, discharge themselves each through half of the coil of the receiving instruments, which are so wound that when no current is received from the distant end of the circuit their effects neutralise each other.

In the event of any inequality in the rate of absorption of the condenser plates, *a*, *b*, means are provided for inserting resistance in one or the other half of the instrument coils, or by rendering the influence of the coil on the needle or magnet by moving the coils to or from the needle.

For working greater length of cables where the rate of speed depends on a well-established balance, the plan indicated in diagram, fig. 2, is employed.

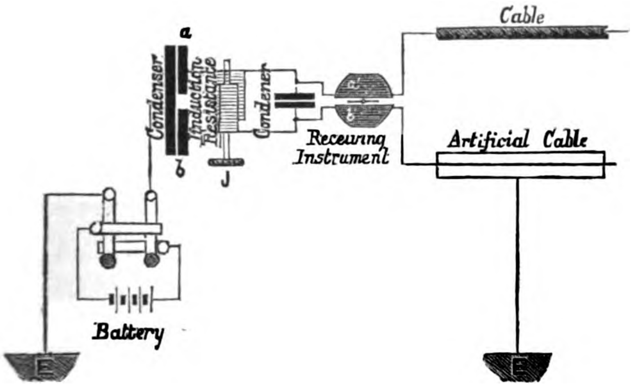

FIG. 2.

In this arrangement one additional subdivided condenser is inserted between the coils of the receiving instrument, a^1, b^1.

The capacity of the first condenser in regard to its plates, *a*, *b*, is as nearly as possible balanced. In the event of any difference in the absorption of the plates, a special form of adjustable induction resistance is employed, which is so constructed that, by means of a screw, I, turning to one or the other side, the difference

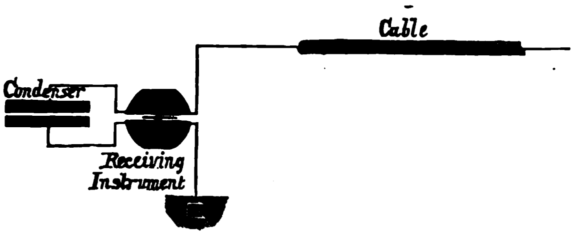

FIG. 3.

in the unequal absorption of the upper and lower condenser plates can be adjusted to a nicety.

Diagram in fig. 3 represents an improved system of working cables by simplex.

The receiving instrument is also supplied with a differentially wound coil or two separate coils.

The condenser is not, as hitherto, placed before or after the receiving instrument, but inserted between its coils, so that one plate is discharged through one part of the coil to earth and the other through the opposite part to cable, thus both discharges passing through the instrument will deflect the needle or coil in the same direction. By this means I purpose to utilise the induction between the coils in assisting the discharge, and so to neutralise the extra current developed in the said coil.

A higher rate of speed is obtained by this system.

ON AN UNEXPLORED FIELD IN ELECTRIC LIGHT OPERATIONS.

[A COMMUNICATION.]

IF conditions do exist under which incandescent lighting is capable of holding its own against any other form of illuminant, they are certainly realised when the installation is neither unmanageably large and complicated, nor too small to profitably employ skilled attendance and supervision.

The electric lighting of towns, hampered by panic legislation and by want of that practical experience in the arrangement of very large installations (which can only be attained by watching their gradual development and growth under every variety of conditions), has up to the present time shown a decided tendency to remain in the "provisional order" stage. And—unless legislators decide to allow a fair and gradual development to take place, and cease to expect that a matured and perfect system of town supply shall be brought forth like Minerva from the brain of Jupiter —we seem likely to remain permanently at that stage.

Since the time when the electric lighting industries were extinguished, domestic lighting has been chiefly represented by the introduction, in a more or less spasmodic manner, of small sets of apparatus for use in private houses, workshops, and business establishments. There are many objections and drawbacks to the isolated installation system—as, for example, the unqualified horror which many persons have of machinery in motion in their own home. Perhaps the most fatal objection is the heavy capital outlay. This bears especially heavily on the small installation, because a small-sized machine costs much more in proportion than a large-sized one. To cite actual figures: a dynamo with a maximum output of 1,500 volt-ampères costs £30, whereas for five times the cost a machine of 13½ times the output can be had. A well-known gas engine is quoted at £90 for a 2¾ indicated H.P. engine; for £350 an engine giving 15 times the indicated H.P. is supplied. Again, for a compound under type semi-fixed engine and loco. boiler a well-known firm quotes as follows:—10 H.P. nominal £300; 50 H.P. nominal, £1,000. In a cheaper class of engine the difference is still more marked. Thus we see that moderately large installations cost much less in proportion than very small installations, as far as prime cost of machinery is concerned.

In considering a town supply system, we meet with a very formidable item in the prime cost of main lines. When these are long and carry "heavy" currents they form a most serious item in the capital outlay, and therefore in the electric lighting rate. Hence the efforts that have been made to introduce systems which combine a very high "pressure" in the main line with a very moderate difference of potential at the house meter terminals. Among such systems the "B. T. K." and the "secondary generators" are prominent, and there is little doubt that a system in which centralisation and decentralisation are combined will eventually commend itself for all operations in districts which

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consist of several small centres scattered over a considerable area.

But in those cases in which a few hundred lamps are spread over a comparatively restricted area, as, for instance, in a block of 20 or 30 houses, the interest on the main lines will be of less importance as compared with the cost of skilled attendance and supervision. If, therefore, we can so arrange that the district to be lighted is broken up into what may be termed "local groups," so as to avoid on the one hand the use of unprofitably small plant, and on the other the expenses attending the laying down and maintenance of an elaborate system of street supply mains, and if we can so spread the cost of skilled supervision over several of these gronps, that its power as a factor in the balance sheet is reduced to a minimum, we shall probably arrive at a very satisfactory medium, if not the proverbial happy one.

In the blocks of houses into which, for the most part, our suburban building estates are cut up, we have a notable example of the proper field for this class of installation, as we find several of its most favourable conditions present—a compact area of supply, an approach to the houses not involving expensive excavation in leading in, a ready means of laying the main lines and of repairing them, and with great facilities for adding branch leads or in any way manipulating consumers' wires. Taking a block of say 30 houses—15 on each side—we may look upon the boundary wall running at the bottom of the gardens, and the party walls running transversely, as so many roads or viaducts specially suitable for carrying cables. (Fig. 1.) If,

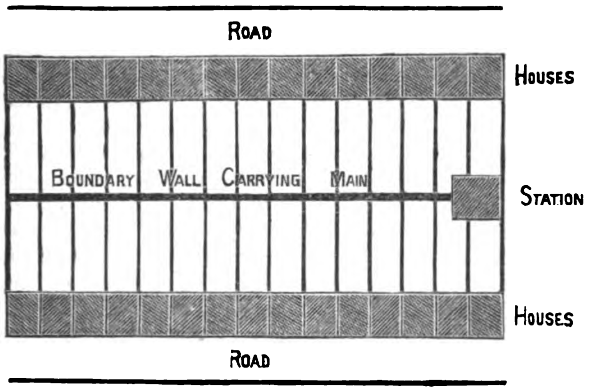

FIG. 1.—BLOCK OF 30 HOUSES TO BE ELECTRICALLY LIGHTED.

then, we can erect a dynamo driven by a gas engine at any convenient spot within the confines of the block we shall be able to supply light (and, if required, power) to any house in that block by simply attaching a branch lead to the main which runs along the boundary wall and leading it from the party wall into the house to be supplied.

The *station* in the figure is shown at the bottom of two of the gardens, forming, indeed, the continuation of the boundary wall. It would contain the dynamo, testing instruments, &c., with a gas engine or similar motive power to drive it. This shed could be built of corrugated iron, ornamentally treated, or covered with trellis work, so as to look as much like a summer house as possible. If the installation were sufficiently large to employ a steam engine and boiler, it would have to be of the most compact and efficient type, noiseless and automatic. In this case arrangements would have to be made to carry the flue-pipe either into the neighbouring copper chimney or into a specially erected iron chimney attached to the wall of the nearest house. It is doubtful whether steam power would commend itself, where a gas engine could possibly be used, on account of the much greater fuss and space which even the best steam engines necessitate, in attendance, storage of coal, water supply, cartage of ashes, &c., besides the element of unpleasantness which arises when a steam engine comes into the vicinity of fidgetty people. But whatever the machinery employed, it would have to be arranged with regard to the utmost economy of space.

The leads would be of the ordinary type, either built into the walls in troughs or simply laid down in wooden channels covered with Λ-shaped pieces of galvanised iron or with Willesden paper—the whole being fastened to the top of the wall. The main line would be tapped at every other wall, and the branch led into the house on either side, for although no saving would be effected in the cost of the conductor, yet only one trough would thus be used where two would be wanted if each party wall carried the line belonging to its own house.

House fixtures would be in no respect different from those used for ordinary installations.

Management and General Working Arrangements.

In new districts specially laid out to afford facilities for this class of lighting the working arrangements would be simple enough. The district would best admit of being profitably worked when several such installations were established within a short distance of each other. In this case one workman could superintend several sets at once, if worked by gas engines or other automatic motive power. This plan should suggest itself to builders laying out new estates, as it would be an undoubted attraction, especially for the better class of houses, to advertise them as fitted and supplied with electric light, with an optional supply of small power motors for driving sewing machines, lathes, &c., &c.

As to the financial side of the question. The works could either be erected by the builders (or at their cost), and the capital outlay apportioned to each house in the block, or the machinery and fittings could be the property of an electrical contracting firm bound by contract to supply electricity at a fixed rate, or on a sliding scale. Again, it might be worked on the cooperative system, and this would be the cheapest way. These, however, are questions which are entirely dependent upon the local circumstances of the case.

I have not thought it necessary to enter into any electrical details of these installations, for the very obvious reason that they differ in no respect from the arrangements for ordinary installations of the same size, and because it has been my purpose to offer food for reflection rather than detail, nor have I considered the question of working by accumulators. Every electrical engineer will have his own ideas on these subjects and will arrange the details in accordance with such ideas.

It is hardly necessary to state that this scheme is not proffered as a solution of the house-to-house supply problem; it must rather be considered as a means of familiarising the public with the light and of rendering the demand for a perfect system more and more imperative, and if it be realisable in practice, it may be looked on as the thin end of the wedge.

A. HAMILTON-CHURCH.

NOTE.—Since writing the above a new petroleum engine has been presented to the market, and if all that is claimed for it be realisable in practice, it should be a decided acquisition for electric lighting. But I have, as yet, seen nothing of importance respecting it.

Uxbridge, *April 12th.*

THE NIGHT PASSAGE OF THE SUEZ CANAL.

NOW that steamers are allowed to proceed through part of the Suez Canal at night with the help of the electric light, the problem for consideration and experimental investigation is how to make use of the light to the best advantage. So far the idea seems to have been to light up the way ahead by means of what is practically an electric bull's eye lamp. This search light is placed at the bow of the vessel, and a gradually widening beam of intense light is directed ahead,

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showing up everything some hundred yards in advance to perfection. The part in the immediate neighbourhood of the ship is, however, left in darkness, made, by contrast, even more intense, so that a buoy near the bow cannot be seen at all, though those a few ships' lengths ahead are plainly visible.

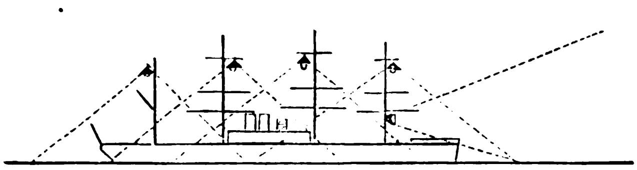
In the case of the P. and O. ss. *Carthage*, the search light was supplemented by two side lights and two stern lights, which were presumably screened from the deck in the same way as the search light, but these, I understand, were of little use.

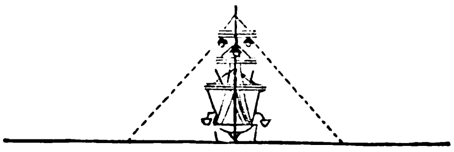
The search light, I hear, was projected through a lens, which made the beam very narrow, not reaching the whole width of the canal until it was two buoys' distance ahead of the ship.

It is evident that a wider angle lens, or a reflector, would answer better, and probably the ordinary naval search light, which has a small reflector in front of the arc and a large one behind it, would suit all requirements.

I think, however, that the system of lighting is a bad one, and that a much better effect may be produced by using the available light in the following manner :—

To take the case of the *Carthage* to illustrate my proposed plan, I will premise that she is a four-masted steamer of large size, having the bridge, if I remember rightly, between the second mast and the funnels. The lamps supplied for her use in the canal were one search light and four presumably less powerful arc lights.





I propose that the four minor arc lamps should be hoisted, one at each of the four masts, at or about the level of the topmast heads, these lamps to be fitted with conical reflectors similar to the ones in use at the Royal Albert Docks, London.

These lamps would light up the whole ship as well as the canal banks adjacent, and the canal itself some little distance ahead and astern. The search light should then be placed about half way up the foremast, or slightly above the level of the pilot on the upper bridge, and the beam directed as far ahead as might be found necessary. In this way there would be good light everywhere, and some extra light ahead, and no light would be in such a position as to dazzle the eyes of the pilot or crew.

My experience of the canal navigation and its requirements, gained while officer in the "Star" and "Orient" lines, leads me to feel confident that the above plan would be found satisfactory.

Those who frequent the Royal Albert Docks will, I am sure, agree with me that there is no difficulty in proceeding through those docks at night, the electric lights overhead making everything distinctly visible.

In 1883 I had occasion to draw up a plan for lighting the canal from end to end by means of powerful arc lights on the banks, but I was always of opinion that, putting aside all question of relative cost, it would be better for each ship to light up her own way ; and I should be in favour of the necessary plant being supplied and worked entirely by the canal officials, so as to secure uniformity of results.

If the canal banks were lined with arc lights, the ones ahead would always shine in the pilots eyes, whereas, if the lighting is done on the ship, no such trouble is possible.

To return to the main point by an illustration : a servant girl looking for a burglar in the coal cellar, holds a light in *front* of her, screens her eyes with her hand, and sees nothing ; but a miner, who has gained knowledge by experience, sticks a candle in his hat *above* his eyes, and sees quite well.

VINCENT STEPHEN.

Author of " Wrinkles in Electric Lighting."

THE HUMAN BODY AS A CONDUCTOR AND AS AN ELECTROLYTE.*

IN the first lecture I made some observations as to the resistance of the human body. I showed that the first difficulty was due to insufficient contact. I ought to have mentioned that I have verified this fact. After taking observations with the wetted poles I spoke of, I thrust two long silver needles into the foot of the dead body, and took another determination ; it came out that although the needles were thrust into the muscular tissue the resistance was on the whole higher than what I had previously obtained. I then showed that another difficulty was due to the fact that the human body rapidly electrolises, and that a current of polarisation is set up within of very considerable power. That topic I wish to go into more closely to-day. I gave the direction in which it is necessary to take a current from hand to hand, from foot to foot, and from hand to foot, and I showed that the size of the patient did not seem to make any great difference, because tall men give, if anything, a lower rather than a higher resistance as compared with short men, the physiological law clearly coming out that as the length of the lever in the body so is the area of the muscles that move it. I gave some examples, and I mentioned an interesting determination which I had been able to make, with the assistance of Mr. Lant Carpenter ; and that I shall again have to refer to in the third lecture.

To-day, I do not wish to speak of the electrolytic action which takes place when a current passes through the body. Now, all fluids are electrolytes, and it is somewhat difficult to measure their resistance in some cases. So, also, are bodies imbibed with fluids, and there have been one or two researches, one by Du Bois-Reymond and another by Comte du Moncel, which I shall refer to again. In the next place, I shall show you how the current has to be taken back again, as in the case of an ordinary fluid cell which has been charged in the usual way. I will charge and discharge two fluid cells connected by a fine tube, which may be looked upon as a sort of electrical schema of the human body. In this case, the resistance is about 1,340 ohms ; the cells which I use are the same, and the E.M.F. in volts is the same as that which I made use of on the former occasion. This is a tube of salt and water, about two millimetres in diameter ; yet it takes nearly ten minutes to charge it all, and even then the vessel is difficult to use. It is easy enough to see by a sensitive galvanometer, and I hope it will be easy to demonstrate it. I must wait some little while until it is properly charged, and, in the meantime, I will make some further remarks.

This polarisation, of course, appears as an increased resistance, and besides Du Moncel's observations, there is an excellent paper by Drs. Waller and de Watteville, in the *Philosophical Transactions* for 1882, which I shall have to quote presently, I found when I came to make these charging and discharging observations that two things happened ; there is an initial throw, then a

* Second Lumleian Lecture, delivered by Dr. W. H. Stone, at the Royal College of Physicians, April 13th, 1886.

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permanent deflection; the galvanometer gives a great start, and then it permanently remains deflected. At first I attributed this initial start to something in the nature of a condenser action, and so I stated it at the meeting of the British Association at Aberdeen. I have been led by Prof. Hughes's beautiful researches somewhat to modify my views on that subject since then, and I think I have mentioned that it might be better designated under the name of self-induction, which I wish to speak of slightly to-day. At the third lecture I shall show that self-induction takes place during the variable period of the current, and that this constant current does not very visibly influence it. This galvanometer which I have here is not intended in any way to show it; but should, as far as possible, cancel it, and only show the permanent deflection. Now this counter E.M.F. is considerably greater than I had anticipated. Presently I shall give you a very excellent measurement made independently of myself, and which is represented in the two curves. The upper curve shows very beautifully what really happens. The first part of the curve below the line of the middle is the period of charge, and all the measurements are given; then the discharge takes place where the vertical line is. The galvanometer shoots up to the point *c*, at the top of the diagram, and goes down again, but not to the line of zero. On the contrary, it remains steadily, and for a very considerable time, very much longer than I had anticipated, discharged steadily through the galvanometer, without losing its charge. In that case, there are ten minutes noted, and the fall in current I shall speak of presently.

In another case, I have been able to produce a very much larger effect than that. That was intentionally taken with a small current, so as to be able to measure it with a delicate galvanometer; but where you use larger E.M.F's., the quantity discharged is quite considerable. I, therefore, will mention some of those cases. They were three patients in St. Thomas's Hospital, and the electricity administered, I need hardly say, was not purely for electrical, but for electro-therapeutic purposes. The first was a case of sciatica, and the patient was very much atrophied in the leg, and was very much wasted altogether, consequently the resistance was somewhat high; it was about 1,900 ohms. I charged him for twenty minutes with ten bichromate cells from foot to foot, putting the copper pole toward the leg suffering from sciatica—and I may say, incidentally, that I cured this sciatica. When I discharged him through a galvanometer, intended to reduce somewhat and modify the indications, the first throw was no less than 250 scale divisions, a very large throw indeed. I then discharged the lead poles to see if they were doing this work, and they only gave 20 scale divisions, so it was actually the patient, and not the electrodes, which had discharged. I passed the same charge through a condenser of $\frac{1}{3}$ of a microfarad capacity, and I got a scale deflection of 30, somewhat more than the poles gave, but infinitely less than what came from the patient.

In the second case I gave a constant current of 14 volts for half-an-hour, from the forehead to both feet immersed in a vessel of water. This was a case of diabetes; and you are perhaps aware that it has been shown that there is a decided decrease of sugar under the influence of a constant current. The resistance here was only 600 ohms, obviously because the conductor was duplicated. I corrected this by Sir Henry Mance's method, and the resistance came down to 543 ohms, although I found there was a polarisation current of no less than 137 ohms, representing all that amount of difference.

The third case which I have to quote was another case of diabetes, in which the resistance was taken in just the same way, but with only six volts, from forehead to both feet. The man could not tolerate a stronger current; he was extremely ill, and eventually he died. I there got 1,100 ohms, and corrected by Mance's method it came down to 1,025 ohms, of which the polarisation current represented no less than 145 ohms. Now this is a very large counter E.M.F., I think a very much larger proportion than would have been expected or than was before demonstrated.

I will proceed with this experiment with the little schema or electrical man a little before the time, after nine minutes of charging. I will discharge it through the galvanometer; I am afraid it will not show a very great deflection: the quantity is very small, but I think it is visible. It will go on for some time before the needle comes perfectly back to zero. I wish to charge the human body and keep it charged some little time. I will substitute the real man for the schema. Again, I shall not be able to do the experiment immediately. The resistance of the real man is somewhat less, but not materially less, than that of the schema.

Whilst that is going on I will take the measuring experiment which I mentioned before, and which I owe to the kindness of Mr. Lant Carpenter and his assistant, Mr. Wilkinson. Some of the resistance determinations I gave at the last lecture, if you recollect. One cell of 2 volts, as near as possible, was put on for four minutes; the actual resistance for the first minute was 1,194 ohms; it rose by polarisation to 1,230 ohms at the fourth; the current passing was ·0016 ampères. Then two cells were put on, and the resistance remained steady, standing at 1,155 ohms. Then comes the test for capacity; and on this test I eventually came to the conclusion that capacity was not the name for this action, although there is something of the nature of a piling up of the current, which is now better called self-induction. In the first experiment two cells were kept on for four minutes, and all the details are given in the diagram. The discharge at the end of the time was 185 divisions. Then the leakage was measured. The leakage on the testing table was found to be absolutely zero. The leakage between my two baths I could not quite prevent; although they were put on an insulating material there was a leakage equal to 142 divisions, without a shunt. This was only ·03 per cent. of the test, and could be neglected. I then tried whether the bath on the floor took any charge themselves; they took 268 divisions, but this was only ·85 per cent. Both these tests came out very much in favour of the accuracy of the observations. Then we got the constant of the two cells. The whole came out at what I have on the diagram, 1,155 ohms with a current of ·00346 ampères.

Then the second experiment, with one cell kept on four minutes, gave a permanent deflection equal to 187 divisions; here, again, we have the 1,230 ohms. Then we discharged the patient himself, with no battery in circuit, through the galvanometer, and under the same conditions exactly, and we got a current from him equal to 60 micro-ampères. Three minutes after it had fallen to 48·7; two minutes after that to 45. Now, that I have thought so important that I have enlarged the curve and given it here on the diagram board. It is very nearly a straight line, and you will see that it discharges itself very much after the fashion of a secondary battery. I was not even satisfied with that, and I gave my two kind assistants a little more trouble. I asked for a curve to be plotted out, in which the original throw, the condenser action, should be blended with a careful appreciation of the charging current and the discharging current. There we have it (see page 395), and I have no hesitation in saying, it is a very beautiful experiment indeed. It opens a grand field for electrical research as applied to the animal body, and more especially the human body. Here is the charging current at *b*; the discharge takes place, and up goes the galvanometer to *c*, and then it comes down and is carried on for ten minutes; the fall of current is so very regular and so very slow that it almost forms a parallel line to the axis of *x*. This is only from 2 volts of current.

We then went on to see how much of this throw would occur with the needle swinging under its own inertia. Another test was therefore taken under the same conditions, using an inert instead of a polarisable resistance—using an ordinary resistance instead of a man. The needle did not reach its previous point, did not fly out so far, therefore the difference between

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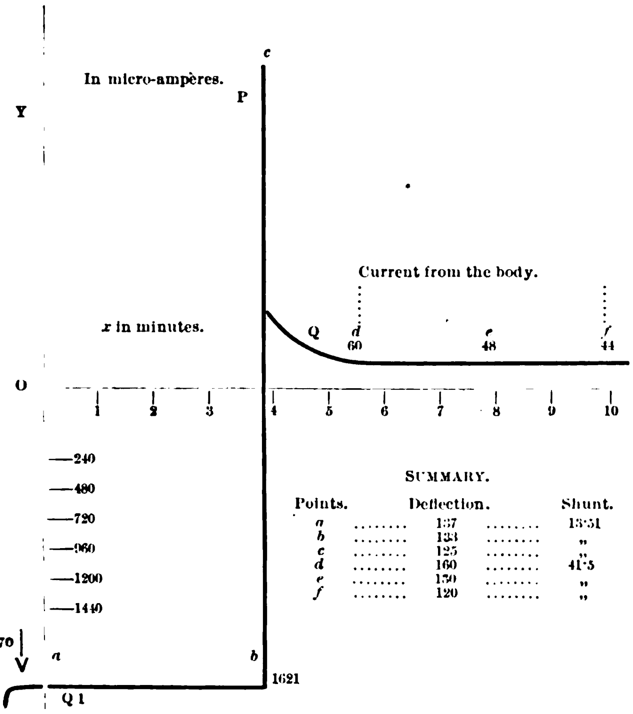
those two must have been the measure of the polarisation which took place. Here [indicating on the diagram] it was from *c* to P. That is a very small quantity, but the E.M.F. was very small indeed, only just competent to combat the counter E.M.F. Water can hardly be decomposed by one cell, and we only had one bichromate cell. Yet we got that very decided difference which I think completely proves what I have been contending. The result of all this is that as regards the electrostatic capacity of the body, it is very difficult to separate polarisation from capacity; and perhaps it is wiser not to say that it is capacity, but that there is self-induction stands before you, I think, in very definite figures.



SUMMARY.

Points.	Deflection.	Shunt.
a	137	13·51
b	133	„
c	125	„
d	160	41·5
e	130	„
f	120	„

Now the ten minutes are up, and I will discharge my human condenser. [Does so.] The deflection is quite visible. Now this has a very important physiological bearing, a bearing on Electrotonus. I confess I always have in former times been sceptical as to the reality of electrotonus. Nearly every writer seems to inveigh against its inconsistency, the difficulty of getting results, and the difficulty of getting the meaning of the results when they are found. Here, for instance, is the last work of Rosenthal, who says:—"It sometimes goes one way, and sometimes the other, and there have been great disputes as to it." Then there is an excellent but rather bulky volume by Drs. Waller and de Watteville, which mentions various authorities, and says that in a determination on the ulnar nerve, Eulenberg and other observers simultaneously came to opposite conclusions. He attributes the inconsistency of the results to the inconstancy of the nervous matter, a view which was followed by many physiologists; but it is rather hard to throw all the blame on the nervous matter. Every one of them assumes so much, and all their results are heterogeneous to the last degree; there is obviously something wrong somewhere. I have felt that for a considerable time, but now I hope we are on the way to see what is wrong. I do not in the least deny that an action does take place such as that which is called electrotonus; but too much stress has been laid on physiological points, and the investigation has been conducted without looking to see that the physical agent is constant under all conditions, and acting under the same circumstances. For instance, Rosenthal lays much stress on anode and cathode, though anode and cathode are purely fictitious terms. We consider that the current goes from the anode to the cathode, but we have no means of knowing that it does; it may go the other way. We call the one plus and the other minus, and we have entirely to assume the upward and downward movement, and the influence of the two poles. This is the first assumption. But we do know something else about the two terminals by electro-chemistry; we know that at the plus terminal in an electro-depositing apparatus oxidation takes place, and that at the minus terminal hydrogen comes off, and is there deposited. We know in this way that if we are not working for the deposition of metal, but take a different body, we have a secondary battery, and I have not the smallest doubt from these observations that these effects are the effects of electro-chemical decomposition. No doubt that chemical decomposition will transmit excitement along the nerve and make the muscle contract, and the inconstant results obtained in that way are due to chemical decomposition of a polarisation kind. There is the more reason to believe this, because we are always finding in books such phrases as these, which are thoroughly unscientific: "When the currents are weak the neutral point lies nearer the anode; when they are stronger it is situated nearer the cathode. When the currents are of a certain medium strength it remains at an intermediate position—that is, exactly midway." What is medium strength? I want it in some physical measure—in ampères. You do not get that anywhere. What we do know is that the medium strength, where the balance is maintained, is the strength which exactly balances the counter E.M.F. of the body, and that is somewhere below a volt. When you get up to two volts you see that the electro-decomposition is clear enough. The certain medium strength which ought to be measured, and which must be measured, is the balancing E.M.F. of the body.

The currents used as a rule by Du Bois-Reymond are infinitely too strong for accurate determinations. He speaks of using 11 or 12 Grove cells, but I should be very sorry to pass the current from them for any length of time through a patient without great precautions. An accident might occur, and in fact in the case of the Comte du Moncel an accident did occur, and Du Moncel only used 8 Daniells, which is about 8 volts, whereas 11 or 12 Groves would be about 29 volts. I think I ought to read, as I might otherwise be misrepresenting Rosenthal, who is a very able man, and one of the great electricians of the German school—I should read his admission, frankly made, that the currents are inconstant. He says:—"If a continuous current is passed through a nerve and is alternately closed and opened, the excitement appears to grow irregular, sometimes at the closing and sometimes at the opening of the current, and occasionally even at both."

There is another error which runs through the physiological observations, and that is what is called the tetanising key of Du Bois-Reymond, which is a short circuiting apparatus, putting a good conductor in the course of the current and, as is supposed by physiologists, entirely cutting off the electrical agency from the larger loop of the conductor tested. But it does nothing of the sort. The law of double circuits is that the currents are divided in the inverse proportion of their resistance; but there is no law that the resistance in a large circuit is ever completely stopped by Du Bois-Reymond's key.

That Du Bois-Reymond key has been, I believe, another source of error and inconstant effects. In fact, Rosenthal, who was a distinguished pupil of Du Bois Reymond, speaking of the key, says: "The lever is made short and thick, and, being made with a short, thick piece of brass, which offers hardly any resistance, while the muscle has great resistance, the current passes nearly all through the key." This is not a scientific or a satisfactory arrangement. It should be none or all. When we add to the constant current the induction coil the problem becomes infinitely more complicated. And when we add, as some observers have done, the continuous and induced currents to one another, in the same stream, I am quite certain that the problem is physically past solution. They have even done more than that. There are induction coils now made in which the current of the primary is transmitted through the secondary complex circuit in

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that way, and then the continuous is added on, all unmeasured, piled on the top of one another, and no wonder the effects are inconstant. One does not know which way the current will run, nor which predominates over the other.

Next comes a most distinct false assumption, which I hope to prove to you at the next lecture; and here I may be doing Drs. Waller and de Watteville an injustice if I do not read the following passage. He speaks of using a constant current and an induced current as the mode of producing electrotonus. He says, respecting the testing current, whether galvanic or induced: "Since the laws of diffusion are the same for both." I do not believe the laws of diffusion are the same for both, and the fact upon which I found that belief I shall demonstrate to you at the next lecture, for whereas my patient gives 1,100 ohms resistance to the constant current, even when corrected for polarisation, to the induced current he only gave half that. I discovered this remarkable fact some little while ago. An induction current will pass through the body and give only a resistance of about one-half to two-thirds of that under a constant current, even when corrected in every way for polarisation. Here is a case where it is curious to observe what happened. The patient gave a resistance corrected by Mance's method of 1,150 ohms—it really came out a little below that, but we will call it 1,150. With an interrupted current he gave a resistance of 575, the exact figures being 1,141 against 575. It is very nearly two to one. Therefore the laws of diffusion, I say with confidence, are not the same for the two. What may be the cause of the difference I am not quite prepared to say at length, but it is clear that this fact must have a physical origin. I will take that up more largely at the next lecture.

I mentioned at the last lecture that we have in the telephone an instrument by which we can reproduce physically many forms of testing machinery which were formerly of a physiological character, and the observation is so interesting that I shall ask you to allow me to go a little more fully into it to-day. I have an interrupter here with which I can make and break a current at different paces; and here you will be able to discover that the result is not only audible, but if you listen to the telephones about the room carefully you will hear that the ticks given by one and the other act are considerably different. There comes a period, if I slide the sledge along, when the tick of making contact disappears. It goes gradually down and fades out. The one tick fades away and leaves the other. This is exactly what has been shown in galvanoscopic frogs, as a means, as it is said, of getting pure excitements. But it is nothing more nor less than what is due to physical action. This can be done without a frog, at a distance, with a telephone replacing the frog. Therefore, I hope I have carried conviction to you.

To me it seems very plain that what Dr. Waller admits when he says that we are dealing with physiological signs alone has been a somewhat dangerous course of action, and that that error has arisen from not measuring our instruments more carefully, and that the prospects of advance in this direction will be by building up from the foundations; by ascertaining what is the force we are using, and how it acts; and then on the top of that to put the physiological determinations. Many of the observations that have been made—and they are very exhaustive (even Du Bois Reymond's volumes alone are the work of a lifetime)—are very interesting, if not convincing. There is another point which has stood in the way of accuracy, and that, I may note, is that over-sensitive galvanometers have been employed. The delicate Thomson galvanometer, beautiful instrument as it is, is so very sensitive that it requires to be very heavily shunted, or you can hardly handle it. The same thing applies to the galvanoscopic frog. We have no means of calculating the accuracy of that. Probably no two prepared frogs have exactly the same power, neither do I see any way of obtaining it. It used to be said we moved up from electroscopes to electrometers when Sir Wm. Thomson discovered the method of measuring in real units. We want to move from galvanoscopes and from physiological shades of action to those which will measure physical units with accuracy. I have great hopes that the telephone will be of service in this way. The telephone is an exceedingly delicate instrument, so very delicate that it almost has the fault of delicacy: but we have the power of improving it, and I will show you at the next lecture that we can use it so that it will take the place of a galvanometer in the ordinary Wheatstone bridge, if you will only interrupt the current; but not in the way in which it is interrupted in an induction coil, but by a small chronometer. Then by our interrupted current the telephone gives a tick and it can be silenced when the two resistances are equal, as in the usual case of the Wheatstone bridge, provided, however, that the two currents are equal in self-induction. The beautiful new instrument of Prof. Hughes not only measures by means of the Wheatstone bridge, but, using the telephone as a galvanometer, measures resistance and also the self-induction. I find that these physiological substances exhibit a very considerable amount of self-induction. The double-wound coils reduce self-induction so much that you can almost take it for nothing; but there is even a better plan suggested by Lord Rayleigh, although it was originally theoretically produced by Clerk-Maxwell—that is, coiling two wires side by side, make one of them a closed circuit, passing the current through the other; in that case you reduce the self-induction to nothing, and that I expect will be the way in which we shall be able to measure the self-induction of compact bodies like the human body. In the meantime, I feel sure that much that has hitherto been done will prove to be purely erroneous, that the investigations, although laborious, have been greatly misunderstood, and, in some cases, ingeniously misinterpreted.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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(*Continued from page* 376.)

Now when the electro-magnet turns, its two branches become alternately magnetised in contrary directions under the influence of the permanent magnet, and in each bobbin an *induced* current is produced. The wires on these respective bobbins *are coiled in such a manner that the two currents help one another, i.e., they both flow in the same direction.* Let us follow the bobbins through one revolution, bringing to our aid a diagram which will materially assist us in our understanding.

We will assume that the bobbins are rapidly turning, and that they have arrived at the position I. Coil A is leaving the N pole whilst coil B has just come upon the S pole of the permanent magnet; thus a current is produced, say, of a *positive* sign—alternating currents are generally said to be *positive* and *negative*—in both coils.

In position II., coil A is approaching the S pole, and coil B is just over the N pole of the permanent magnet, the current in both coils being the same as before.

Thus you see in half a revolution of the electro-magnet we have two currents induced in the coils of the same character.

You think the impression might prevail in the minds of the unscientific portion of our readers that the currents should have been in opposite directions, or alternating?

Perhaps it may, for I fancy I omitted to say that whether a given coil *approaches* the N pole or *recedes* from the S pole of a magnet, the current induced therein is the same.

You agree with me that this has made the dubious

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point clear? Well, we will now proceed with the remaining half revolution, which will complete our cycle of operations.

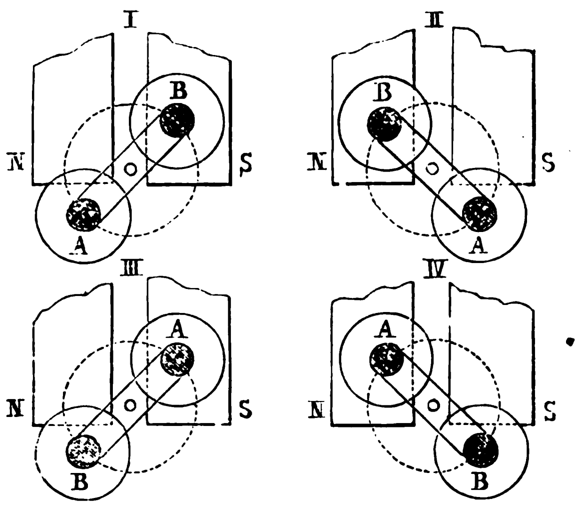


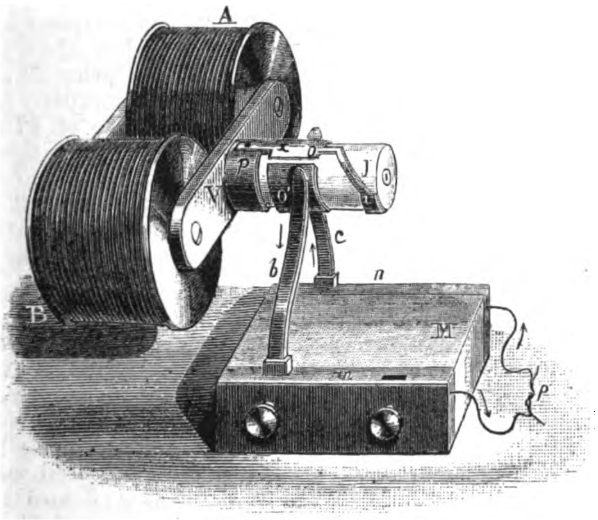
DIAGRAM ILLUSTRATING THE PRODUCTION OF CURRENTS.

In position III. the coil, A, has become uppermost whilst B is underneath. You perceive, therefore, that both portions of the electro-magnet are reversed as compared with I., and you can with certainty conclude that the currents are now also reversed, or *negative.*

The same is seen if we compare II. and IV., therefore we find that during the complete revolution of the electro-magnet we obtain four currents, or electrical impulses of an intermittent nature, two being in one direction (*positive*), the other two in the reverse direction (*negative*).

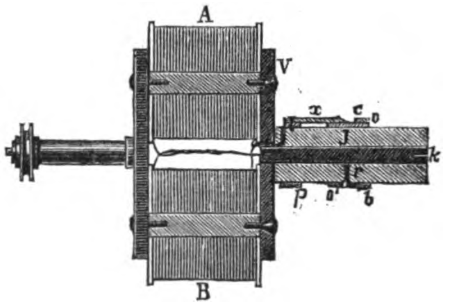
I hope this will be clear to all who may take an interest in me and my doings in the past, present or future; and now to show how these alternating currents —which for some purposes answer well enough—may be commutated so as to pass always in the same direction.

You did not think the commutator on the Pixii machine large enough to enable us to clearly observe its action, and I promised you an enlarged one for the purpose we have in view. It is this—



COMMUTATOR.

The apparatus consists of a cylinder J, made of insulating material, such as wood, ebonite or ivory, and through which runs a copper cylinder of smaller diameter fixed to the armature, V, and turning with the bobbins or electro-magnets, A, B. On the insulating cylinder is first a metallic (brass) ferrule, *p*, and in front of it two half ferrules, *o* and o^1, also of brass, and completely insulated from one another; *o* is connected metallically with *p* by a tongue, *x*. On the sides of a base of wood, or other insulating substance, M, there are two brass plates, *m*, *n*, to which are attached two flexible springs or rubbers, *b* and *c*, which press successively upon the half ferrules, *o* and o^1, during the time the bobbins are in motion. Now upon glancing at the sectional view of the commutator it will be seen



SECTION OF COMMUTATOR.

that two ends of the coils of the electro-magnets (in the same direction with respect to the currents passing through them) terminate in the metallic cylinder, *k*, and by means of the screw, *r*, are connected with the half ferrule, o^1; while the other two ends—both in the same direction with respect to the current—are in connection with the ferrule, *p*, and also, therefore, with the half ferrule, *o*, through the tongue, *x*. It follows that *o* and o^1 are the terminals or poles of the alternating currents, which are developed in the bobbins, and, as we have already explained, they must therefore be alternately *positive* and *negative.*

If we now assume a case in which o^1 is *positive*, the current descends by the spring, *b*, goes through plate *m*, and by a connecting wire, *ρ* to *n*, whence it ascends, *c*, and is closed by contact with the piece, *o*; then, as rotation goes on, *o* takes the place formerly occupied by o^1, thus keeping the current in the same direction, for, as it is then reversed in the *bobbins*, *o* has become *positive* and o^1 negative, and thus it continues so long as the bobbins are turned.

With the springs, *b* and *c*, alone, I must tell you, the currents from the two pieces, *o* and o^1, could not unite unless *m* and *n* are joined by the wire, *ρ*. The same result, however, may be obtained by means of a third spring, which I brought before your notice in Clarke's adaptation of my Pixii form, and of two connecting pieces not distinguishable in that figure, but one of which, *i*, can be traced in the foregoing view of the commutator. These two pieces communicate respectively with *o* and o^1, and, as often as the third spring touches one of them, it comes in contact with spring, *b*, and the current is closed between the two springs and then reaches *c* by means of the plate, *n*.

Well, it may not be altogether so easy to follow me as I had anticipated, and, indeed, I am not sure but that I have gone beyond my original intention when I singled you out to act as my mouthpiece. It might have been best to make the simple statement that currents of alternating character or opposite sign can be changed into continuous ones by means of a simple apparatus called a commutator. However, it is useless to regret it; the thing is done. And now to continue my historical career.

(*To be continued.*)

Electric Light Plant Burnt Out.—Mexico, Mo., will have to do without her electric light, for a while at least. About 12 o'clock midnight, on the 9th inst., the engine house situated in the rear of the business houses on the west side of the square was discovered to be on fire, and not until everything in the building was ruined were the flames subdued. In a few moments two streams of water were playing upon it, and as a result the whole west side was saved. About twenty lamps were used in business houses, besides the public square being lighted by it.

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ABRIDGMENT OF THE NORWEGIAN PATENT ACT OF JUNE 16th, 1885.

Under this Act (which came into force on January 1st, 1886) patents are granted for new and useful inventions, medicines and articles of food being, however, excepted, but patents may be obtained for the process or apparatus for producing such products.

Each application for a patent (which must be limited to one invention) is subjected to examination by a Patent Commission. If the papers are not in proper form, time will be allowed to amend them, but if the alleged invention is manifestly wanting in novelty, or otherwise unpatentable, the application will be refused. If, on the other hand, the application be accepted, it is advertised and the documents are made public by being thrown open to inspection. (This publication may be delayed at the request of the applicant on payment of an additional fee). Opposition may then be entered during eight weeks. The Patent Commission has then sixteen weeks within which to come to its decision.

Should the applicant be dissatisfied with the decision of the Patent Commission, either in its preliminary or final examination, he may lodge an appeal within six weeks, and in the event of the result of such appeal not being satisfactory, he may enter a second appeal within four weeks.

Should the decision after the lapse of the period for entering opposition be favourable to the applicant, a patent will be issued forthwith.

The application for a patent must be made within six months of the invention having been published by printing or public exhibition; the inventor is, however, bound to make it known when he publishes the invention that he intends to apply for a patent for it.

The first inventor, or a person deriving authority from him, is alone entitled to a patent, but where, in the case of there being several applicants in respect of the same invention, it cannot be ascertained which is the first inventor, the patent will be granted to the first applicant.

For a period of two years following the date of the patent, the patentee has the exclusive right to protect improvements on his patented invention by a certificate of addition terminating with the original patent.

The duration of the patent is fifteen years from the date of the application, subject to the payment of a small annual tax, which is progressive. The tax may be paid three months after it becomes due, with a fine.

The effect of the patent is that no person, except for his own use, shall, without the consent of the owner, make the patented object, or import it from abroad, nor shall sell or even negociate for the sale thereof.

When the subject of the patent is a process, an apparatus, a machine, a tool or other implement, the patent has further the effect that no person without the consent of the owner of the patent shall use the invention in his business. This provision will not, however, operate to prevent the use of objects relating to navigation on ships bound for a foreign port but stopping in Norwegian waters.

The patent will, further, be inoperative against any person who, prior to the patent application, may have used the invention in Norway or made the necessary preparations for such use.

A patented invention may, by decree of the King, be used in the public service, likewise where it is of essential importance to one or other of the branches of trade connected with articles of food, it may be thrown open to private persons. In either case the owner of the patent will receive compensation, which, in default of agreement, will be settled by arbitration.

The invention must be worked in Norway, or the patented object placed on sale there, within three years; and such working or placing on sale must not be subsequently interrupted one year. This last-named term may be extended by the Patent Commission for special reasons. The Patent Commission will, in special cases, give directions as to what is required for the working or placing on sale.

There are ample provisions for dealing with infringements, the infringer being required to compensate the patentee for any damage he may have caused him, and, further, where the infringement is intentional, being mulcted in a fine and liable to have the infringing goods confiscated.

A year is allowed from the January 1st, 1886, for the owner of a patent granted under the old law to exchange such patent for one issued under the new law, subject to the result of the official examination, in particular as to novelty at the date of the original patent.

Norway is a party to the International Convention so that an English patentee will have six months within which to apply for a Norwegian patent for the same invention. T. J. Handford.

The Philadelphia Pole Tax.—Judge Hare, of Philadelphia, has rendered an opinion respecting the decision of the referee in the suit brought by the city against several telegraph and telephone companies to recover the license fee of $5 upon telegraph poles, that the fee was excessive, could not be sustained, and referred the case back to the receiver for reconsideration.

NOTES.

Ship Lighting. — The finely-modelled steel screw steamer recently launched from the yard of the Sunderland Shipbuilding Company, Limited, and built to the order of Messrs. Welmer, Ashton & Co., of Manchester, on behalf of Senor Joaquin Redo of Mazatlan, Mexico, is fitted with the electric light, the main saloon being brilliantly lighted. A separate electric light is also provided for each berth. The second class saloon and berths, together with both officers', engineers', and crews' accommodation, as well as the engine room, stokehole, and other parts of the vessel, are also lighted in the same manner. The electric machinery is by the well-known firm of Messrs. Siemens Brothers, and fitted by Messrs. Dorman and Smith, of Manchester.

The Grangemouth Dockyard Company has secured the contract for the building of two screw steamers. They are intended for the passenger trade in the East, and will both be fitted with the electric light throughout.

The Electric Light and Gas in America.—A comparative statement just published shows that New York has 23,038 gas lamps and 647 electric lights; Boston, 9,781 gas lamps and 401 electric lights; Baltimore, 5,191 gas lamps and 243 electric lights.

Electricity in the Navy.—A permanent electric staff is to be formed at Chatham Dockyard, where a certain number of the best fitters in the factory have been selected to be sent to Portsmouth yard for instruction in electrical work, with the staff at that establishment. On the fitters completing their course of training at Portsmouth they will return to Chatham, and form the nucleus of a permanent staff of electricians at that establishment.

Electric Lighting in California.—The Jenney Electric Company, of Indianapolis, has commenced the lighting of the enterprising city of San Diego, Cal., this being the first plant installed on the Pacific Coast by the company named. The contract runs for five years, and is for four towers, the price being $1,200 a year per tower. So much satisfaction, however, has been felt with the light that an additional tower has been ordered, whilst it is stated that there is a probability that still more will be required. Each tower is equipped with six 2,000 C.P. lamps. The local gas company had been charging $5 per 1,000 feet for gas, but when the electric lighting commenced, reduced the price 20 per cent. In addition to the city lighting the company has subscribers for 30 private lights at the rate of $15 a month each. As yet only arc lights have been introduced, but the company proposes also to supply incandescent lights for its central station, and will, it is stated, have these in operation in about two months. The station has three 30-light dynamos, and a Buckeye engine of 70 horse-power.

Electric Effects on the Stage.—One of the newest and most successful effects with electricity on the stage is that introduced by the Stout-Meadowcroft Company for the American Opera Company in New York. It is known as the "Firefly." Fine, invisible wire is suspended across the stage, and connected with a large spark coil and 24 "luminous points;" and the passage of the current causes an instantaneous flashing of the points all over the stage.

Electric Lighting of a Parisian Library. — The library of the Conservatoire des Arts et Métiers is to be lighted by electricity. It is the first Parisian library which will enjoy this advantage. The inauguration takes place this week, on the occasion of the meeting of the several scientific congresses, which generally assemble in Paris during the week following Easter.

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Electric Lighting in Speyside. — Writing to the *Scotsman* last week, a correspondent gives a description of the system of electric lighting introduced in Doune House, Rothiemurchus. He says the water-power available has been used for this purpose. The wooden building—15 by 10—which contains the dynamo and turbine is situated about three-quarters of a mile from the house, and the current is conveyed therefrom to the 18 accumulators, which are placed in an outhouse in the courtyard of the house. Advantage has been taken of the house main water pipe to effect considerable economy in wire, it having been utilised for a length of about 1,000 yards as a return. The turbine, which is of 2 horse-power, works with a head of only 10 feet of water, the necessary speed for the dynamo being obtained by means of a countershaft. The machinery is started about an hour before the lights are required, and continues running without attention till 7 a.m. the following morning, when it is stopped, unless a very large number of lamps have been lighted for an unusual length of time, in which case the dynamo is run until the accumulators are again fully charged. The total number of lamps, which are of 10 candle-power each (Swan's incandescent), is 100, of which 50 to 60 are lighted nightly, and the dynamo being run at the same time, prevents an undue drain upon the accumulators when on special occasions all the lights may be used. Safety fuses are placed in every direction, so that there is absolute immunity from all risk of fire. The entire installation has been carried out by the engineer, with the assistance of two local carpenters—one working all the time, the other for a few weeks as well. Both are exceedingly intelligent young men, and the management of the machinery and accumulators, &c., is now entirely in their hands. The cost of the electric installation has been £400, including carriage of plant to this distant spot. The cost of lighting this house the year round hitherto has been £70, colza oil having been used in preference to mineral oils, to lessen risks of fire. The estimated yearly cost in the future is £25 for renewal of lamps, brushes for dynamo, machinery oil, and chemicals for re-charging accumulators. The saving of work in cleaning and preparing lamps is considerable, and the coolness, cleanliness, and brilliancy of the new mode of light is much appreciated by the household.

The Poet and the Electric Light.—The advent of the electric light in San Diego, where it was introduced by the Jenney Electric Company, was hailed by the local poet in the following terms :—

Tell me, Mr. "Jenney" man,
  How you "strike" a light;
Do you climb those iron poles
  With your matches every night?
I know the climb-it here is good;
  But is that the way you do?
Tell me, Mr. "Jenney" man,
  For I wish I knew.

Tell me, Mr. "Jenney" man,
  Will it be very bright?
And who is this "smart Aleck"
  That got up this Aleck trick light?
Surely he's a Boston man,
  And cultured very high;
Tell me, Mr. "Jenney" man,
  Will he be here by-and-bye?

Tell me, Mr. "Jenney" man,
  Will it shine just like the moon?
Will we have to light a lamp
  When we go into our room?
Will we have to take a lantern out
  When to church at night we go?
Excuse me, Mr. "Jenney" man,
  But all this I'd like to know.

Electric Lighting Act Committee. — Mr. W. H. Massey, electrical engineer in the Royal Household, has retired from Lord Thurlow's Committee, in consequence of the action taken recently by the executive council with reference to the Bills now before the House of Lords.

Liverpool Exhibition.—The Liverpool Electric Supply Company, which secured the contract for the lighting of the Shipping Exhibition throughout with the electric light, has arranged with Messrs. Walter T. Glover & Co., Salford, Manchester, for the supply of all the electric light cables and wire.

The Telephone on Lightships.—The lightship anchored about ten miles off Walton-on-the-Naze, in the Swim passage, is now in regular telephonic communication with the town. The name of every ship is telephoned to the Walton post-office, and some 90 craft pass the lightship every day. One rough night a vessel got on the sands, and the lifeboat was telephoned for, but was subsequently stopped by telephone when about to start, because the craft eased off, and a night of exposure was thus saved to the lifeboat crew. The cable has once been broken, but was re-united within 24 hours.

The Telephone at the Law Courts.—Arrangements are in progress for the opening of a telephone office at the Royal Courts of Justice for the convenience of barristers, solicitors, and other subscribers who may have business there. The office, which will be situated on the North Court corridor, between the Lord Chancellor's Court and Chancery Court III., is expected to be completed very shortly.

Guthrie's Telephone.—A contribution to the telephone controversy in America comes from Leesburg, Ohio, where it is reported that Mr. J. T. Guthrie experimented on the transmission of speech by electricity long before Bell received his now famous telephone patent of 1876. It is stated that Mr. Guthrie has now perfected a new form of telephone quite different from any previous device. A patent has recently been granted to him for a telephone which is operated by a direct instead of an induced current of electricity.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to April 24th, 1886, amounted to £60,000, against £65,000 received from April 1st to April 25th, 1885.

The Singapore-Penang Cable.—The ss. *Seine* started on Monday week to lay a new section of cable between Singapore and Penang.

Cable Inspection.—We hear that the ss. *Volta* is now engaged in picking up and examining the first direct Spanish cable, the condition of which is reported to be doubtful. The bottom which is found off the north coast of Spain is irregular, and subject to submarine landslips, and it is a pity that, when this cable was duplicated, the company were content with changing the types of cable, instead of changing the route. That no real improvement was effected is proved by the fact that the new cable broke down within a year after it was laid; whereas, if a new route had been chosen, this cable might still be regarded without anxiety.

The Rate-cutting War.—Acting in sensible fashion, the Commercial Cable Company has decided, we learn, not to reduce its tariff to the low charge of 6d. per word for the transmission of messages between the United Kingdom and America, which the other Atlantic cable companies, acting in concert, have adopted, but to reduce only to 1s. per word, trusting that the public will support it upon the strength of its past work in procuring a reduction from the rate of 2s. per word. No doubt the bulk of the trans-Atlantic traffic will fall into the hands of the combination, whose cables will in all probability become congested. Those who wish speed and certainty for the transmission of their messages will, in this state of affairs, undoubtedly pay the additional 6d. per word, and it must be remembered that only half the proportional amount of traffic will be required to produce the same monetary result.

The following circular has been issued by the

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Commercial Cable Company (Mackay-Bennett cables): "We beg to inform you that on and after the 5th prox., until further notice, the rate for telegrams by this company's cables to all points in the United States of America, Canada, &c., will be reduced to 1s. per word. The 'pooled' Atlantic cable companies, consisting of the Anglo-American, Direct United States, French, and Western Union, have made strenuous efforts to induce this company to raise the tariff to 2s. 6d., and as we have refused to accede to their wishes, they announce a 6d. rate. It is known full well that this rate would result in a serious loss to all the companies, but the 'pooled' companies think by adopting this extreme measure, the Commercial Cable Company will be forced to come to terms, and raise the price to the figure desired. The Commercial Cable Company commenced business at 1s. 8d. per word, being a reduction of 20 per cent. on the then existing charge, and the amount of patronage we have received proves that the rate is a popular one. It was the intention of the Commercial Cable Company to regard 40 per cent. as their maximum, gradually reducing the price as opportunity offered. The earnest wish of this company is to maintain the 1s. 8d. rate, and to this end we ask the public to make a temporary sacrifice by supporting us at 1s., on the assurance that if we are vigorously backed up now the tariff shall return to the original figure, viz., 1s. 8d."

It is unfortunate that at this interesting juncture the Duxbury section of the French Atlantic cable is reported as broken down, for this will doubtless add to the difficulty which the "pooled" cables will experience in dealing with the increase of traffic which may be expected.

It will, to a dispassionate observer, be interesting to watch the shearing of that lost sheep, the "Anglo" reserve fund. Can it be that the heroic band of shareholders, who are the property of the combined companies, are not only defending their own interests but are also attempting to cripple a company which may otherwise take a leading part in uniting the Australian colonies with England, by the proposed Sandwich Island, &c., route (which was referred to by Mr. J. Pender at the recent meeting of the Eastern Extension and Australasian Company)? If this be indeed the case, the Eastern and allied companies ought to be deeply grateful for an attention, which, while it is coincident with their own interests, has the additional merit of costing them nothing.

Killing Dogs by Electricity.—The Kimberley Borough Council, on the recommendation of its electrician, Mr. R. L. Cousens, recently resolved that in future all dogs that were captured without license ticket, and no owners appearing to claim them, should be dispatched by means of electricity, as the method of poisoning, used previously, was by no means effective, the brutes frequently lingering from half-an-hour to two hours before death ended their misery. The dogs are put into boxes, which can be opened at each end, at the bottom of which are fixed, on insulators, two copper plates, separated from one another by about three inches, so that the fore feet of the dog may rest on one plate, and the hind feet on the other. To the copper plates are fastened two wires which lead to two switches hanging on the wall. One of the Brush machines, which lights twenty-three of the lamps during the evening, is connected with the switches. The copper plates in the box are moistened with salt and water, in order to secure better contact between the paws of the dog and the plates; the dog is put into the box, the ends being closed, then when the fore-paws are on the one plate and the hinder ones on the other, the switches are closed, and the machine is short circuited. The moment the short circuit is taken off, the current goes through the body of the animal, and it is instantaneously killed. The only time taken up is in the act of putting the dogs into the boxes and taking them out again. On one occasion 23 dogs were killed in less than the same number of minutes.

Great Blasting Operation.—A recent account of the progress of the works which the London and St. Katharine Dock Company commenced in 1884 for the enlargement of the Tidal Basin of the Royal Albert Dock and the formation of a new entrance suitable for the increased draught and dimensions of new ocean liners, stated that the solid concrete wall which bounded the basin on its north-east side was being prepared for blasting away. Last Friday morning at six o'clock the great blast was successfully performed. The wall, reduced in thickness to four feet six inches at the top and at the bottom to six feet, was pierced with 1,430 holes about four feet apart, and these were loaded with charges of gelatine dynamite varying from 8 lbs. at the base to $\frac{3}{4}$ lb. at the top. All these charges were put in at the back of the wall, its front remaining intact supporting the water of the basin. The total length of the wall was 520 feet, and the estimated weight of material, flint, and pebble concrete, 7,850 tons. The electrical wiring for the simultaneous discharge of this multitude of shots was carried out by Messrs. Siemens, who have the lighting of the Docks, the plan of operations having been submitted by the Dock Company to Sir Frederick Abel. One of the alternating machines used for shed lighting, and in its ordinary working giving off a current of 48 ampères at 600 volts, was coupled up in series to develope a high tension current of 24 ampères at 1,200 volts, to suit it for firing the high tension Abel fuzes which were to be employed on the occasion, this being the first time that such a large number of this class of chemical fuzes have been employed, platinum wire or low tension fuzes being usually adopted for this kind of operation. Two well insulated main leads of copper wire were brought from the ordinary electric lighting station beyond the Galleons Basin, and were carried along the rear of the wall. Two additional mains were also carried from the machine and united with the first mains about the middle and at the end of the wall, so that if any damage or defect occurred at any point in the transmission of the current it would have independent means of percolating the network system of branches which were taken off from the mains to the fuzes. The transmitting mains were tapped at the firing station, erected near the bridge, at the western extremity of the basin, by a tumbler-switch, by a blow upon which the electrical current could be instantaneously put into circuit. The total length of branch wires was over six miles, and the total quantity of gelatine dynamite employed was stated to be 2,860 lbs. Six feet of the wall was above the level of the water in the basin. The operation was performed in the most successful manner, and upon inspecting the site of the blast, it was found that the wall had completely disappeared, except half a dozen large blocks, one about four feet long, which had been thrown about 20 feet, and lay on the road. The divers at a later period reported that the material had been reduced to small masses not exceeding a ton weight, and smaller on the average.

Alleged Libel on Mr. Hugh Watt.—At Westminster Police-court last week, Mr. Richard Fyfe, 40, an engineer, of Moreton Terrace, Pimlico, was charged on a warrant with publishing a malicious and defamatory libel of and concerning Mr. Hugh Watt, M.P. Mr. Tickell, barrister, appeared for the prosecution, the prosecutor not being in attendance. The sworn information disclosed the following facts:—The prosecutor is a merchant in the City of London, and chairman of the Maxim-Weston Electric Company, Limited. At the end of March last the defendant, who had been in the employ of the company, was summarily dismissed, and not only the prosecutor, but others had received very scurrilous letters and communications, those addressed to the prosecutor reflecting on his conduct not only as a director of a public company, but in his private capacity as a citizen. Two of the directors of the company, Messrs. Louis Swabey and John Brown, had received letters from the prisoner at their private residences, and these letters had been handed over to the prosecution. One of the letters was couched in the

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following terms :—"I was never locked out of my house and my wife gone, the brokers in charge of a house on the hire system. I am a gentleman. Richard Fyfe. Copies forwarded to your constituency, feather directors, shareholders, &c. Act at once, R.F. You will very likely pay my claim. I am in possession of a paper proving Watt a liar, signed by two shareholders. Richard Fyfe." Sergeant Edwards, the chief warrant officer of the Court, proved the arrest of the defendant, who stated that the prosecutor had sent him a letter threatening him with seven years' penal servitude, and he had consequently called him a liar. Mr. Partridge asked if defendant showed any letters. Edwards re plied in the affirmative ; the letters the defendant produced he stated he had received from the prosecutor. On the way to the police-station he said that he had been to Glasgow during the late election, and was there for six weeks, at great personal expense, furthering the interests of the prosecutor. He also added that he had been instrumental in causing the return of the prosecutor to Parliament, and that the treatment he was then receiving was his reward. Mr. Tickell asked for a remand, as the prosecutor was not present. The defendant observed that in his opinion, it was very unfair to apprehend him early in the morning without any notice, especially as documents now in the hands of his solicitor would explain everything. He could produce one letter from the prosecutor containing a deliberate threat. Mr. Partridge observed that even were that true, there could be no justification for libelling the prosecutor. There must be a remand, but bail would be accepted in £30. Bail was immediately put in, and defendant left the court with his friends, stating excitedly that he would expose the prosecutor.

Mr. Fyfe has since taken out a cross-summons against Mr. Watt for libel.

The Norwegian Patent Laws.—In another column we publish an abridged translation of the new Norwegian Patent Act. The Scandinavian countries are greatly improving their patent law, Sweden having taken the lead about 18 months since. Denmark is too much distracted with political complications at present to give us much ground for hope that the much needed reform in its patent law will be accomplished for some time to come. We believe there is a good field for electrical inventions in the Scandinavian States, so probably anything bearing on the protection accorded to inventors in those States will be of interest to our readers.

Electrical Dissipation of Smoke.—Professor Oliver J. Lodge concluded a highly interesting lecture on "Fuel and Smoke" at the Royal Institution recently by showing the effect of an electrical discharge upon dust or smoke. A bell-jar, connected with a frictional machine, was filled with smoke. Two turns of the generating machine was sufficient to clear the jar of all the smoke. On the electrical discharge passing through the jar the smoke coagulated and deposited itself on the bottom and sides of the vessel in snow-like flakes. What might be the development of this peculiar power of electricity Professor Lodge said he did not know, but he felt that something ought to come of it. Certainly lead fumes and other similar nuisances arising from industrial processes could be condensed and got rid of by means of this process. At the close, Professor Lodge intimated that he would deliver a lecture upon this application of electricity at the Royal Institution next month.

That Lineman. — The invasion of private property by linemen has caused serious complaint in this country as well as in America, therefore the following story from that country of one party's experience will not be uninteresting :—"You know where my place is ? Well ; under the sidewalk in front I heard some pounding one day, and went down to investigate. Two of the worst looking men I ever saw outside a penitentiary were taking out a huge stone to bring through an electric light wire. I stopped them, and sent them off packing. I gave orders to my help under no circumstances to let them into that area again, and I had a lock put on the door. A week afterward I had occasion to go there, and bless my spectacles if they hadn't picked a hole through on either side of me, fished their cable through my premises with a hooked wire, and had the lamps running over a week before I found out that I was burning lights on that same circuit ; but my loop came down from the roof. Well ; I caught a telegraph man on my house. The health people had ordered a ventilator, so I put up a wooden shaft three stories high, and in less than 24 hours this critter had found it and was putting in a ticker line down my shaft. I afterward found a wire which had pulled down half a chimney, and there was no telegraph, telephone, ticker or district company who would own it. As the wire was what all these fellows called a 'dead' wire, I cut it. When the owner came, about half an hour afterward, bless me if it wasn't one of my old friends the electric light men, who had been bounced for not going through my area, or rather for getting caught and stopped, and was now working on over-head wires. I expect all telegraph men will get to heaven. If they can't climb the wall they'll go under it."

Electric Light v. Gas.—In Chester, Pa., the fight between electricity and gas has resulted in the reduction of the price of gas from \$2. to \$1.70 per 1,000 feet. The gas company has offered to let the city have gas at \$1·50, if 250,000 feet is burned. It is understood that the electric people will offer to light the city all night for a reasonable advance on what is now paid for light until twelve o'clock.

Longfellow on Lightning.—In the life of Longfellow, just issued, the following happy little passage is quoted from his diary :—"Lightning is a ferocious visitor when it comes to a man's house, bursting in so unceremoniously, yet ringing all the bells to announce his presence, and away again after shaking hands with the inmates and dancing wildly on the bell wires. A kind of Robin Goodfellow with his ho ! ho ! ho !"

Atmospheric Observations.—An interesting series of observations were recently made by gentlemen connected with the United States signal service simultaneously at Boston, Columbus, O., Washington, D. C., Ithaca, N. Y., and at Yale College, New Haven, Conn. The observations at Boston were taken in the basement of the new building of the Massachussetts Institute of Technology. They were continued at intervals of five minutes during a period of 72 consecutive hours. The observations, which were taken by means of the electroscope, were for the purpose of ascertaining the variations of atmospheric electricity and humidity, during the period named. The object of taking the observations simultaneously at different points throughout the country was for comparison, in order to ascertain whether the varying atmospheric conditions are similar throughout the country or are simply local. It is believed that the results of the observations will be of great value to the signal service in the prognostication of storms, and it is hoped that by this means some new laws of storms and atmospheric disturbances may be discovered.

Telephoning from Moving Trains.—The discussion over the "air telegraph," of which recent trials have been made with much success, is, states the New York *Electrical Review*, still prominent in telegraph and railroad circles, where all imaginable claims and prophecies are made for this new discovery of the extent and force of induction. Yet it can hardly be called a new discovery, for the first patent (No. 247,127) was issued to W. W. Smith, now of Kansas City, Mo., on September 13th, 1881, nearly five years ago. About a year ago, Mr. T. D. Lockwood, the electrician and patent expert of the American Bell Telephone Company, searched the records very carefully, and became convinced that the Smith patent was the very first in this particular field, either in England or the United States.

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Electric Tramway Locomotion.—On Thursday night and Friday morning last week, the directors of the Electric Locomotive and Power Company, Limited, had a private trial trip in an ordinary tramcar drawn by one of the Elieson electric engines. It was the second engine built by the company, and carried 70 cells. The car was one of the ordinary large cars of the North Metropolitan Tramways Company used on their line to Aldgate. With the view of interfering as little as possible with the traffic, and also to avoid a crowd, the start was delayed until the last car had finished its return journey from London, viz., about one o'clock on Friday morning. The route was from Stratford Church to Stepney, and everything was done to put the engine to a fair test. The rails were not in the best order, in fact they were in some places undergoing repair. The route was of an undulating kind, and the rails were somewhat greasy from a slight rainfall. The result was of a most satisfactory kind. The journey occupied 25 minutes. The engine and car were lighted with electric incandescent lamps, and were perfectly under control. Several stoppages were made on the different gradients, and these, as well as the respective startings, were considered satisfactory. The gradients were:—Stratford Bridge, 1 in 27; Sewer Bridge, 1 in 48; Bow Bridge, 1 in 30; Bow Church, 1 in 30; Bow Station, 1 in 32.

Petroleum Engines.—In his article on electric lighting operations Mr. A. Hamilton-Church refers to a new petroleum engine as being placed upon the market. We have every reason to believe that everything claimed for this motor will be realised in practice, and that it must be largely employed in electric lighting.

Incandescent Lamps.—Mr. Arthur Shippey proposes to use 16 candle-power lamps taking about 1·7 watts per candle-power as the most economical and safe for small installations. Although he speaks of the lamps manufactured by his firm as being of this "happy medium," we ask permission to doubt his statements. Other portions of his letter are so palpably absurd that we must decline to publish further communications of the kind.

Cable Working.—It is not often in these days of electric lighting that suggested improvements in submarine telegraphy are forthcoming, or at all events made public. The article which we publish by Mr. Ebel will therefore be all the more appreciated by those who are directly engaged in submarine telegraph operations.

Self-induction.—The discussion on the recent paper of Professor Hughes bids fair to produce much desirable information upon a subject not yet thoroughly understood. No doubt great interest will be manifested in the professor's new apparatus.

The Weston Laboratory.—A description of Mr. Weston's electrical laboratory appeared in last week's issue of *Engineering*.

New Cable in South Australia.—Accounts have just reached us of the successful laying of a cable from Yorke's Peninsula to Althorpe's Island. It is stated that the new cable will not be of great commercial value, although it will be of service in apprising the public of the shipping traffic between the two gulfs. The cable is 8 miles in length, about 2 inches in diameter, and armoured with ten thick galvanised wires, each three-tenths of an inch in diameter. It was manufactured by the Telegraph Construction Company, and was conveyed to Port Adelaide in the *Orissa*. It was laid amidst general rejoicings in the commencement of last month.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Miners' Electric Safety Lamp Company, Limited.—An agreement, dated 19th ult., relates to the purchase by this company from Mr. Benjamin Nicholson, of 57, Coleman Street, the sole right to use, exercise, and work for mining purposes the following letters patent, viz., No. 489, dated January 31st, 1882, for "Improvements in electrical batteries for telegraphic, telephonic and other purposes;" No. 4,460, dated December 19th, 1882, for "Improvements in and connected with batteries for generating electricity;" also Nos. 10,002 and 11,521, of the year 1884. The purchase consideration is £99,903, payable in fully paid shares. Registered office, 10, Old Jewry, E.C.

United Telephone Company of the River Plate, Limited.—At an extraordinary general meeting of the shareholders in this company, held at 131, Wool Exchange, Coleman Street, on March 25th, it was resolved that the Articles of Association be altered as follows: "In article 68, the expression 'nine-twentieths' shall be substituted for the expression 'one-twentieth.'" This resolution was confirmed on the 9th ult., and was duly registered on the 20th ult.

Electric Locomotive and Power Company, Limited.—An agreement, dated 3rd inst., and filed on the 22nd inst., provides for the issue of 1,564 shares, to be considered as fully paid up, after £3 6s. 8d. per share has been paid in respect thereof. The capital of the company has recently been increased to £60,000 in £5 shares.

Electrical Power Storage Company, Limited.—The annual return of this company made up to the 8th ult. was filed on the 27th ult. The nominal capital is £200,000 in £1 shares. 147,450 shares have been issued and are fully paid up.

Electric Lighting Supply and Fitting Company, Limited.—A final meeting of the shareholders in this company was held on the 21st ult., when an account was given as to the manner in which the winding up of the company has been conducted and its property disposed of.

Laing Electric Light and Power Company, Limited.—The registered office of this company is now situate at 13 and 14, King Street, Cheapside.

Latimer Clark, Muirhead & Co., Limited.—The last return filed by this company is made up to the 14th April, 1885, and was registered 7th May, 1885. The nominal capital is £100,000 in £10 shares. 4,702 shares have been taken up and are fully paid.

Shipping Appliance Company, Limited.—The registered office of this company is situate at 7, Fenchurch Street, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Railway and Electric Appliances Company, Limited.

THE third ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel, on Wednesday, under the presidency of the chairman, Colonel R. Raynsford Jackson. The following report was submitted to the meeting:—

Whilst in many respects there is a marked improvement upon the previous period, the result of the working is still unsatisfactory. The waggon cover fastener, the patent for which is held by the company, has contributed a considerable sum to revenue, all the transactions in this article having been of a profitable character. Fair progress has also been made with the jointless compensator for railway points, &c., introduced by Mr. Henry Williams, the manager of the company's works in Glasgow; and the reports received from the different railway companies which have adopted it are encouraging. The directors have secured the

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working of several other patents for railway appliances, on royalties, and without having to make any preliminary cash payments, and it is anticipated that these arrangements will materially benefit the company. During the year various contracts for general railway work were secured, and in nearly every case the profit derived was fully as much as could have been anticipated at a time when trade is so universally depressed, and the competition is so excessive. It has not been possible, however, to secure sufficient work of a paying kind to cover all fixed charges, consequently there has been a loss of £848 16s. 4d. on manufacturing account. This is appreciably less than that incurred during 1884, and £8,182 0s. 2d. less than that of the previous period of about 18 months. The machinery and plant have been efficiently maintained out of revenue, but there being no net profit available for the purpose, provision has not been made for any further depreciation. The debit to profit and loss account for the year, including the loss of £848 16s. 4d. on manufacturing account, amounts to £3,753 15s. 2d., as against £4,601 0s. 11d. in 1884, which included £700 for depreciation of original stock. It will be noticed that the debit balance for 1885 includes the sum of £2,000 charged for directors' remuneration for the year, as fixed by the Articles of Association, but on reference to the balance sheet it will be seen that it has not been taken. Although the directors do not feel called upon at the moment to forego their right to claim the full amount, they do not, in the present circumstances of the company, contemplate appropriating more than £450 for their services during the last year. It will also be seen from the balance sheet that the amount to the credit of share capital "A" account has been materially reduced in pursuance of the compromise with the litigant shareholders referred to in the last report, and that a sum of £16,996 3s. 6d. stands to the credit of suspense account against the balance of £23,143 19s. 6d. to the debit of profit and loss account. The 50,050 fully paid-up shares which were to be surrendered under the compromise with the vending companies, have been transferred to trustees for the benefit of this company. In order to relieve the balance sheet of these shares, which are not now represented by available assets, it is expedient that they should, as soon as practicable, be cancelled; but as the Articles of Association do not at present authorise the directors to accept a surrender of shares, an additional article empowering them to do so will be proposed at the extraordinary general meeting, in the terms set forth in the notice convening the same. It has been the special aim of the directors to conduct the company's operations to a successful issue without having to make a further call, but various causes have prevented this, and, in their opinion, the interests of the company now require that more capital should be placed at their command; hence they have come to the conclusion that it is expedient to make a call of 2s. 6d. per share on the 51,701 shares upon which, up to the present time, 12s. 6d. per share has been called, and they trust the shareholders will concur in this measure. This would produce £6,462 12s. 6d., and, in order to cause as little inconvenience as possible, the directors propose to defer the date for payment until the 15th July next. Did the directors not fully believe that there is still a prospect of establishing a good business for the company, they would not have taken this step; and it must also be borne in mind that should the company be wound up, a heavy call would have to be made for the purpose of equalising the 12s. 6d. shares with the fully paid shares which have not been surrendered.

Mr. W. Shepherd, the secretary, having read the notice convening the meeting,

The Chairman said it was out of his power to report that there was any marked improvement in the affairs of the company. There had again been a loss at the Polmadie works, amounting, with the addition of the expenses in London, to £3,753 15s. 2d. This was a heavy loss considering the financial position of the company, but it was somewhat less than the loss in the previous year, when the amount was £4,888 16s. 7d.; this last mentioned loss, however, was swelled by £700 depreciation, and no depreciation had been taken off the stock this year. The loss in the works was £1,885 in 1884; in 1885 it was £845. He wished to point out, however, that although the loss appeared as £3,753, it was practically not so much, because an amount of £2,000 was credited to the directors for their fees. But, as the directors intended only to appropriate to themselves £450, the loss was practically reduced by the difference of £1,550; it was therefore £2,003. The directors would, however, reserve control over the remainder of their fees, in order that they might, if need be, meet contingencies like those which arose in 1884, when they pocketed no fees whatever; they did take a certain amount, but they spent that amount in meeting liabilities which would otherwise have fallen upon the company itself. The circumstances under which those payments were made had already been explained, and it was just possible that similar circumstances might arise so as to make it expedient for the directors to use in the interests of the company, and for the defence of their policy, part of the amount which still remained to their credit. He trusted the need would not arise, and he saw nothing looming before them which would lead him to think it possible that it would; but he thought it necessary to make this explanation. The circumstances which had told against the company during the last year were not, perhaps, peculiar in any way to this company. There was no doubt that the depression of trade, which had long been of such grave importance, still continued unabated, and, in addition to this, as far as regarded this company peculiarly, they had to face a disappointment. At the last meeting he informed them that the "Williams" cross-over had been successfully applied on one railway, and that they had received a second order for it. This second installation had given satisfaction to the railway company, and the directors felt encouraged to suppose that it was most likely that other orders would be given to the company for the cross-over. They had been disappointed in that anticipation; they had not received a single additional order for anything made under the patents of Mr. J. S. Williams. There could be no doubt that there was merit in his inventions; still, he was not at all surprised that the managers of the railway companies should act in a conservative sense in regard to that which affected their roadway. They might probably anticipate that one of these days they might come to hold a higher appreciation of the value of what he (the Chairman) believed was an important invention. The circumstances telling in favour of the company were that there was a continued demand for the waggon fastener, for which the company held the patent, and also an increased demand for the compensator, which the company also controlled; and the company had secured licenses for the use of some inventions upon payment of royalties, without in any way trenching upon its funds, and these arrangements they hoped would produce beneficial results. Another circumstance which was perhaps still more important, was that they had received a large order for general business from an important railway company, whilst smaller orders had also been received from other railway companies, so that there were indications that their business in that particular direction would develop hereafter somewhat more freely. He could not say that he was able to put before them a sanguine picture; but, at the same time, he thought they ought not to give up hope of seeing the company in a better position. He concluded by moving the adoption of the report and accounts.

Mr. F. G. Smith, a shareholder, seconded the motion.

Mr. Cumming asked as to the item of £3,898 for law expenses.

The Chairman stated that the company was engaged in a great number of law suits, and it had been the effort of the present directors to get rid of these suits and free the company from the embarassment, even ruin, which would have been the inevitable result had they not been got out of the way. The result of the arrangement made was that the company had to pay pretty heavily to the legal profession; nothing like so heavily, however, as would have been the case had the litigation continued.

Mr. Cumming further enquired what steps had been taken to recover the sum of £444, arrears of calls.

The Chairman said that arrear was principally due from one shareholder, who had held 900 fully paid up shares, which had been cancelled. They had a judgment against this shareholder, and it was a question whether they should take advantage of the Bankruptcy Act to force him to pay.

Mr. Cumming: Can you give me any idea of the turnover for the waggon fasteners?

Mr. Smith, a director, said something like 70,000 or 80,000 had been disposed of. The value of the fastener was not great, but the profit was very considerable.

Mr. Cumming suggested the sale of the Polmadie works, and the continuance of the manufacture elsewhere.

The Chairman said if they came to the resolution to sell the works and conduct only an agency business they might as well go a step further and wind up entirely. The directors, however, thought they might put the business in a better position by continuing the works. There were indications that they would soon be better employed. If those indications were not fulfilled, the directors would consider it their duty to consult the shareholders upon the condition of affairs before the time for the next meeting.

Mr. Smith, replying to a question as to the compensator, said they might form some idea of its value from the fact that in the specifications just issued by the North Eastern Railway Company for a contract, it was laid down as absolutely necessary that these compensators should be supplied, so that, even though this company did not get the contract for the general business, they would supply the compensators, of which, perhaps, 30 or 40 would be used. Wherever these compensators had been used—on the Caledonian, North Eastern, North British railways, and elsewhere—they had won universal approval.

The Chairman then read a letter from a shareholder, Mr. Arthur R. Jackson, who said he was prevented at the last moment from attending the meeting. He had at previous meetings supported the directors against the opposition they had met with, and did not wish now to become antagonistic to them. At the same time, after perusing the report, he thought the company was in such a desperate condition that he did not think they were justified in advising the proposed call. He had intended to move a resolution for the appointment of a committee of independent shareholders to investigate the position of the company prior to the passing of the report, and, as he could not attend, he desired that his letter should be read. Referring to this letter the Chairman said the directors had received a very large number of proxies, which, if they were used at all, would be used, he supposed, in support of the report. Then he might intimate that if the company were wound up the course that would have to be taken would be that the uncalled capital would be called up, and that and the assets of the company would have to be divided amongst the 12s. 6d. shareholders and the fully paid up shareholders. In that case the ordinary shareholders would not get back all the 7s. 6d. they would have to pay up.

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Mr. Cumming: Would they get anything?

The Chairman: I hope so; but a great deal would go into the pockets of the paid up shareholders.

Mr. Cumming: Then it is a question of either paying the calls in the endeavour to resucitate the company, or paying them to the liquidator to be handed over to the paid up shareholders?

Mr. Smith said that was exactly the position. They must consider whether it was better to wind up and absolutely part with £5,000 or £6,000 to paid-up shareholders, or to strive, by submitting to a small call now, to bring the company into a paying condition. If they only covered expenses and kept the company going, making no further call, it would be better than appointing a liquidator, who, whether friendly or hostile to the directors, would immediately have to call up the 7s. 6d. unpaid.

The resolution was then put to the meeting and carried unanimously.

The retiring directors, Sir George Prescott and Mr. W. A. Smith, and the auditor, Mr. James Worley, having been re-appointed, the meeting was resolved into an extraordinary general meeting, when the following was added to the articles of association:—

"Art. 38A. The directors may accept from any member, on such terms and conditions as shall be agreed, a surrender of his shares or stock, or any part thereof."

A vote of thanks to the Chairman terminated the proceedings.

Indo-European Telegraph Company, Limited.

THE nineteenth ordinary general meeting of this company was held on Wednesday at the Cannon Street Hotel, Colonel James Holland, the chairman, presiding.

Mr. W. Andrews, the managing director, having read the notice convening the meeting,

The Chairman said that before submitting the report (which appeared in the REVIEW last week) to the meeting he would remark that it was a very satisfactory thing for the board to be able to submit a report so satisfactory in all its features. It showed an increase of upwards of £18,000 over that of the preceding year, which itself was not a really bad one. The balance sheet called for little remark, but there was one item worthy of notice, viz., the small amount of law charges (£40) for the year. That was very satisfactory to them, but hardly so to their excellent solicitor, Mr. Bristowe, who so well conducted the business of the company. That gentleman had for some years been their legal representative, and on all occasions whatever he had done had been most satisfactory. While they had made upwards of £18,000 in excess of the preceding year, the expenditure was somewhat less than that of the preceding year. There was an crease of £1,600 to enable them to work the much greater traffic they had had, but that had been more than compensated by the improvement in the accounts for maintenance. That charge had for some time past been improving, and much had been done to keep the line up to the highest standard of efficiency, so that it was next to impossible for anything to be better. But, in spite of that, the cost of maintenance was £1,700 odd less than in the preceding year. If anything could add to their deep debt of gratitude to the managing director, Mr. W. Andrews, he thought that fact alone would go to their hearts, which in the case of shareholders were said to reside in their breeches pockets. One of the causes (after awarding all praise to Mr. Andrews) of the present satisfactory state of things was that they had always taken care from the beginning to have no increase of their capital charges. Whatever expenditure had been incurred had been taken from revenue. Day by day expenses were paid up, and they had nothing lurking behind to give them the slightest apprehension. Their costs were paid as incurred, and the capital was in no way watered. They hoped to be able to carry on that system, and then he saw no reason why the same satisfactory progress might not be relied on year after year. From the line being in so efficient a state they might naturally infer that the company might go on realising the large profit of last year. But he must certainly put a damper on any extravagant hopes of that kind, because, as was stated in the report, the large augmentation of revenue is quite exceptional, and is owing to the total interruption of the Eastern Company's lines for some three weeks, the disturbances in Burmah, and the Afghan frontier question, and it is satisfactory that the £18,046 11s. 4d. of additional revenue has only occasioned an increased expenditure on commercial account of 1,637 7s. 7d. They must not, therefore, expect that kind of revenue every year. Wars and political disturbances had during last year proved exceptionally beneficial to them. But they were like a two-edged sword, and cut both ways. They had had sad experience of the injury war could do them in the war between Russia and Turkey, when some 60 miles of their line was destroyed and their capacity for earning revenue stopped for some time. So that, although war might sometimes prove beneficial, as during last year, from the large amount of political intelligence that passed over their line, it might be just as damaging. Their truest friend was commercial prosperity, which unfortunately had been at a low ebb. All they could do was to hope that things might mend, and that commercial prosperity might last. That it might be of advantage to them it was necessary to do their utmost to satisfy the commercial public. They could do that by working the line, as they were doing, in the most efficient manner. He had said to whom that was mainly due. Merchants were satisfied with the way the work was done; but they might say that heavy prices were charged for that good work. The company, therefore, in view of the profit they had made for some years, and in the hope that trade would improve, had, at the last quinquennial conference of the different telegraphic authorities of Europe, proposed to reduce the rate of 4s. 7d. a word for India to 4s. The Indian Government was anxious to see such a reduction as might be fairly made, and therefore that tariff would come into operation from the 1st July next. Considerable reductions had also been made in the trans-Indian charges to China, Malacca, and other places beyond India, varying from 1s. to 1s. 6d. per word. The reduction was an argument why they must not expect an overwhelming profit year by year; for every reduction told upon the gross profit, whereas dividends were paid out of net profits. In addition to the reduction referred to, they were now consulting with the Post Office and with other companies in regard to a considerable reduction in the Press rate, a measure originally proposed by their company, and carried out in the first instance by the East India authorities, who were partners with them in this concern. That was a satisfactory partnership, because the influence of the powerful Indian Government shielded them to a great extent from unreasonable competition, on the one condition that their line worked in the most perfect manner that was possible. If they failed in that respect they would be liable at once to find competitors in the field. There would be no lack of exertion on their part to prevent that occurring, by utilising every discovery of science. Their line was only valuable as a going concern, and any political convulsion which destroyed it would render it valueless—a very strong argument for greatly increasing their reserve. Of course, though they had reduced their tariff, they were in hope that the usual increase which usually followed reduction might tend to recoup them. The Chairman then formally moved the adoption of the report and accounts.

Mr. Weaver seconded, and the motion was carried unanimously, as was also a resolution declaring a dividend of 17s. 6d. per share, making, with the interim dividend, 6 per cent. for the year, and a bonus of 30s. per share, free of income tax, making in all 12 per cent.

The Chairman and Mr. H. H. Meier were re-elected directors; C. F. Kemp, Ford & Co. were re-elected auditors; and the proceedings closed with a vote of thanks to the chairman and board.

Reuter's Telegram Company, Limited.

THE twenty-second ordinary general meeting of this company was held on the 22nd inst. at the offices, Old Jewry, under the presidency of Colonel James Holland.

The Secretary having read the notice convening the meeting, and the report, published in the REVIEW last week, having been taken as read,

The Chairman, in moving the adoption of the report, expressed the great regret of the directors at the fact that, for the first time in the annals of the company, they were unable to pay a dividend. Having quoted from his remarks at the last meeting, when he prepared them for this contingency, he stated that it had not been in their power until a very late period to moderate in any way their agreements with the Press, as they were for fixed dates. After those dates had expired they made representations to the Press, who had agreed, in future cases of wars or great disturbances such as to necessitate a considerable addition to the expenditure of the company, that they would increase the amount of their remuneration to an extent which would practically prevent any recurrence of the company's present position of not being able to pay a dividend. They had a hope at the last meeting that warlike operations had ceased or were about to cease, and that, therefore, notwithstanding the heavy expenditure they had incurred without return, they might have a moderate profit at the end of the year; but since then, from Khartoum to Burmah had been one unceasing round of wars of one kind and another. The Rangoon affair, although a satisfactory matter as regarded the interests of the country, had been, as all wars were for the company, unfortunate, as it had caused them to incur considerable expenditure. They had also suffered from the depression of trade and the depreciation in silver, their remittances from India having been very considerably "watered." Referring to the balance sheet, he stated that the various items under the heads of sundry debtors and sundry creditors had all run off. As regarded the future they would, in the event of the contingencies mentioned arising, receive increased payments from the Press; and although they had not yet made up their receipts account for the first quarter of this year, they knew that the expenditure on telegrams in that period had been over £2,000 less, compared with the corresponding period of last year. They also had no bad debts. He concluded by referring, with regret, to the absence of Baron de Reuter (whose health compelled him to reside abroad for some time), and to the death of Mr. J. S. Stopford, one of the original directors of the company.

Admiral the Right Hon. Sir J. C. D. Hay seconded the motion, which was carried unanimously, and the retiring director and auditors were re-elected.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 23rd were £1,959, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending April 23rd amounted to £2,487.

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NEW PATENTS—1886.

4553. "Deposition of platinum by electricity." W. A. THOMS. Dated April 1.

5479. "Gauging electric currents: apparatus for that purpose." S. C. C. CURRIE. Dated April 20.

5531. "Pole pieces of dynamo-electric machines." W. T. GOOLDEN, A. P. TROTTER, H. W. RAVENSHAW. Dated April 21.

5532. "Electric furnaces for the manufacture of chemicals and utilising substances obtainable thereby." W. P. THOMPSON. (Communicated by Cowles Electric Smelting and Aluminium Company.) Dated April 21.

5542. "Regeneration or production of chromic acid from exhausted battery and other solutions." D. G. FITZGERALD. Dated April 21.

5564. "Pneumatic despatch tubes." J. G. WALKER, J. NEWTON. Dated April 22.

5565. "Automatically controlling the inrush of air into pneumatic despatch tubes." J. G. WALKER, J. NEWTON. Dated April 22.

5588. "Dynamo-electric machines." W. M. MORDEY. Dated April 22.

5606. "Electric switch." W. H. PREECE, J. W. WILLMOT. Dated April 22.

5611. "Generating electric currents." H. H. LAKE. (Communicated by Helios Electric Light and Telegraph Construction Company.) Dated April 22. (*Complete.*)

5664. "Electric motors and transmission of power therefrom." M. H. SMITH. Dated April 24.

5677. "Electro-galvanic brush for the hair, &c." T. W. LAWSON. Dated April 27.

5700. "Raising and lowering telegraph or other cables." A JAMIESON. Dated April 27. (*Complete.*)

5725. "Electric arc lamps." E. G. BREWER. (Communicated by D. B. Macdonald and H. W. Woodman.) Dated April 27.

5731. "Galvanic batteries." A. DUN, F. HASSLACHER. Dated April 27.

5745. "Insulating compound for electric conductors or cables." H. H. LAKE. (Communicated by W. P., H. B. and J. Tatham, and D. Brooks.) Dated April 27. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

16437. "Improvements in the preparation and application of materials, fabrics and structures suitable for the construction of electric apparatus, cells, chambers, or dielectrics, and for other purposes." J. S. WILLIAMS. Dated December 13. 6d. In carrying this invention into practice in its application for dielectrics or separating plates or partitions between the electrodes or elements of accumulators or batteries, the inventor takes sheets or plates of iron or other metal, suitably perforated or rendered porous or honeycombed, or metallic gauze or asbestos fabrics or paper similarly perforated, or strands, wire, or ribbons of such material built up so as to form sheets or fabrics, and subject such material to a process of enamelling by which the surfaces of such material are coated or covered by a protecting coating of vitreous enamel or glaze. He fills up the interstices, or spaces or openings, or perforations, with a chemically and electrically neutral porous material, such as with powdered asbestos or pumice stone, or kaolin or ganister, or compound soluble silicates, or a combination of such or equivalent material, which may be mixed with a suitable cementing agent, such as Roman or Portland cement, or equivalent substances.

16438. "Improvements in electric accumulators or batteries, their construction and operation, and in apparatus or means employed therefor or therewith." J. S. WILLIAMS. Dated December 13. 6d. Relates to batteries or accumulators adapted to be charged or revivified or maintained in a working condition through the action of an electric current, or by the actions of gases or media for restoring or maintaining the elements in a working condition, they being provided with electrical connections led off from the co-operating electrodes of opposite signs from the tops of those of one sign and the bottoms of those of the other sign, and from the corners or parts thereof diagonally opposite. Also in combination with this improvement the inventor employs electrodes or elements provided with electrical connections or electrical channels at the ends or edges thereof, having an electrical conductivity approximately equal to or greater than the conducting or transformable capacity of the electrodes or series of leaves thereof. Also in combination with one or both of these improvements, or either of them, he employs compound interlacing electrodes or folded electrodes.

1885.

3446. "Improvements in and relating to electrical generators and motors." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated March 17. 1s. 1d. The object of this invention is to so construct an electro-dynamic motor or dynamo-electric generator that it will be self-regulating, so that the motor may be made to run at a constant speed under varying loads, in a circuit either of constant current or constant potential; or the generator may develop a constant current or a constant electromotive force. The motor used is a differential motor—that is, one having two sets of field coils, one in series with the armature, which is termed the "governing coil," and the other in shunt relation to the armature. The latter coil is of higher resistance and greater number of turns than the former; it is the principal coil and determines the polarity of the field. The inventor has found that a certain proportion must exist between the main coil and the governing coil to give the best results either with constant current or constant potential, and it is in this that the invention chiefly consists.

4141. "Improvements in the appliances for, and mode of, connecting, clamping, and holding the cables, wires, and conductors used in the transmission of electric currents." O. MARCH. Dated April 1. In a block *c*, figs. 1 and 2, of brass or other suitable material, and preferably of an approximately cylindrical form (with or without flanges, f^1, at the base for attachment) is cut a vertical slot of suitable width from the top downwards to within about ¼ of an inch from the bottom. A hole, *e*, is drilled transversely through the block, *c*, aforesaid, and at a distance of about ¼ an inch from the bottom of the latter; said hole, *e*, being drilled or formed in such a way that its axis passes through the block, *c*, at right angles to the plane of said slot. In the slot aforesaid is placed a metal slide, *d*, of a thickness suitable to allow of its being readily slid up and down in the slot. The metal slide, *d*, is formed at the top with, or has attached to it, a screw which passes, as shown, through a suitable nut, *a*, resting

FIG. 1.

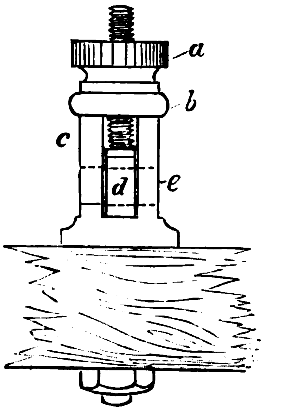
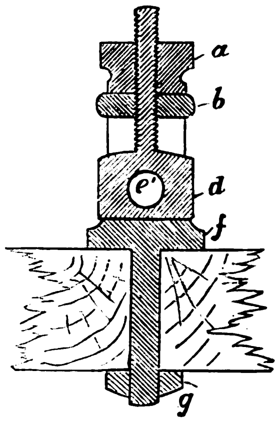
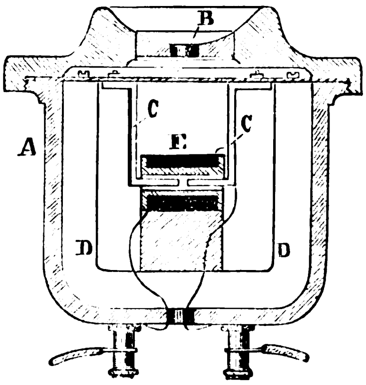


FIG. 2.



on the top of the slotted block. A hole, e^1, is drilled through the metal slide, *d*, and of a diameter corresponding with that of *e*, the hole formed through the block, *c*, in such a manner as to ensure that when the slide, *d*, is at the bottom of the slot, the corresponding hole, e^1, in the slide is opposite the hole, *e*, drilled in the block, *c*. The cable or conductor is passed through the holes, *e*, e^1; and, on the nut being screwed down, the slide is raised, and thus the cable or conductor becomes clamped between the bottom of the hole in the slide and the top of that in the block. By the means above described cables or conductors (of any size that can be passed through the holes, *e*, e^1), can be securely clamped; and, in the case of stranded wires or cables, without displacing the strands, as also in such a manner as to secure efficient electrical contact. By a modification of the arrangement, a wire can be secured at any intermediate point in its length; for this purpose the portion *d* is made of a hook form.

4423. "Improvements in electro-telephonic instruments." S. P. THOMPSON. Dated April 9. 8d. The object of the invention is to construct telephonic instruments very cheaply and of



great power and efficiency, especially when used as receivers, although they may be used as transmitters if desired. A is the

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box or case of the instrument in which is held the elastic or stiff body or spring, B, which may be of mica, ebonite, wood, brass, or other non-magnetic and elastic material. At or towards the sides or edges of this spring piece, B, pieces, C, are attached, the said pieces forming part of a magnetic circuit by reason of their being in proximity to the magnetised bar, D, the said pieces, C, being preferably attached to the spring, B, so that they can move independently of the main body of the magnet, D, to which also the spring, B, may be attached, as shown. Around, but preferably not touching the approximated ends of the pieces, C, is fixed the coil, E, in connection with the external wires.

5808. "An improvement in cable grapnels." H. C. MANCE. Dated May 12. 6d. The inventor attaches to an ordinary cable grapnel certain bars which act as fenders, keeping the prongs clear of rocks, but in no way preventing the cable being hooked when the latter is clear of the ground. The grapnel is balanced so that it travels over the ground with the prongs clear of the bottom instead of searching in the mud, sufficient spread is given to the fenders to cause the prongs to remain clear of rocks, and there is sufficient clearance between the end of the fenders and the points of the prongs to allow of a cable being hooked the moment the fenders are clear of it.

5828. "Improvements in the mode of vulcanising the insulating covering of electrical conductors." B. J. B. MILLS. (Communicated from abroad by J. J. C. Smith, of America.) Dated May 12. 6d. A sheet of the insulating compound is laid firmly on a long sheet of heavy tin foil, and then both are cut in long narrow strips. Such strips of tin foil, in combination with the vulcanisable insulating material, are laid on the wire by means of the covering machine. When the insulating cover is to be vulcanised the covered wire is coiled on a large but light metallic reel in two or three layers. This reel is so arranged that it may be put readily in and out of the vulcaniser, and that it can be revolved horizontally in the vulcaniser while the same is closed and in operation. When the vulcanisation is completed the wire is taken out, and the tin foil envelope having performed its function, is removed from the insulating covering, leaving a smooth and dense surface.

6286. "A novel telescopic swinging and rotating pendant and switch for one or more incandescent electric lamps." A. GRUNDY and G. W. READY. Dated May 22. 8d. Relates to the arrangement described in the No. of the REVIEW for August 1st, 1885.

7461. "Improvements in galvanic batteries." A. R. UPWARD and C. W. PRIDHAM. Dated June 18. 8d. Relates to gas batteries constructed in the following manner:—Each battery cell consists of an outer and an inner vessel, the latter is porous, and both vessels may be of earthenware. On either side of the porous vessel the inventors introduce into the outer vessel a carbon or negative element, and the void space around it and between the two vessels they fill with broken and moistened carbon. They introduce into the space on one side a pipe preferably of glass passing down nearly to the bottom, and on the other side a pipe dipping down a short distance only. They then apply pitch, or other like cementing material, to seal in the space between the two vessels at the top, but leaving the inner porous vessel open at the top. When the battery is at work chlorine gas is admitted to the space to circulate amongst the broken carbon, entering by one pipe and passing on by the other. The porous vessel receives the positive element within it; this element is usually zinc, but iron may be employed. The positive element is simply immersed in water or liquid which the porous vessel contains.

8036. "Improvements in electric telegraphs." H. C. MANCE. Dated July 2. 8d. The object of the invention is to improve the apparatus for translation of telegraphic signals automatically between two circuits (cables or land line) when relays of an extremely sensitive or unstable character are employed, although designed more especially to meet the requirements of the Brown-Allan relay, the improvements can be worked in connection with other relays and telegraph apparatus. The general arrangement of the connections for automatic translation would be substantially similar to that of other systems of double current translation. The improvements consist of a clockwork with suitable mechanism and contacts contrived and arranged, to obviate the difficulty caused by the uncertain character of very sensitive relays, which sometimes come to rest with the local current open and sometimes with it closed.

14288. "Improvements in dynamo-electric machines." J. A. BERLY. (Communicated from abroad by Z. T. Gramme, of Paris.) Dated November 21. 6d. The object of the present invention is the construction of dynamo-electric machine frames in one single hollow piece, the said piece constituting at one and the same time the bed plate, the cores of the electros, the polar pieces, and one of the bearings of the machine. The complete frame of the dynamo-electric machine is obtained by the addition of a second bearing.

15276. "Improvements in telephonic and other call apparatus." E. F. FROST. Dated December 12. 8d. Relates to certain improvements in individual telephone signals of that class in which step by step devices are actuated by a current of given direction to circuit the bell, which is then actuated by impulses of reverse direction; and it consists in a novel combination of a transmitting apparatus with the signalling devices in such manner that any office may signal another on the same circuit without the aid of the exchange by means of a slight modification of the usual magneto-generating machine; also in an improved form of magneto-generator for operating the signals; also in a novel arrangement of the connections through the transmitting and magneto-generating devices.

15344. "Improvement in electric registers and recorders intended for registering, recording, and checking fares, sales, receipts, entrances and exits, change of conductors or other persons operating said registers and recorders, and for similar purposes." E. A. SCALES. Dated December 14. 8d. Relates to electric alarm registers and recorders, and consists in the circuit closer for operating such a register; means of preventing the register from recording more than one fare at a single closing of the circuit; means of causing the apparatus to register before sounding the alarm; means of producing a permanent record of the number of times the circuit is closed and means of recording a change of conductors.

15455. "Improvements in electromotors and dynamo-electric machines." J. C. MEWBURN. (Communicated from abroad by W. Main, of America.) Dated December 16. 8d. In these improved machines there is no reversal of current in the exciting coils, and consequently no current is consumed in forcing a reversal of polarity to overcome residual magnetism and effect a repulsion of the mutually receding masses of iron.

15617. "Improvements in electrical switches." H. B. BOURNE and H. R. F. BOURNE. Dated December 19. 6d. The object of the invention is to insure that the making or breaking of the contact in an electrical switch shall be independent of the control of the operator.

CORRESPONDENCE.

Suggestions as to Testing the Merits and Life of High and Low Resistance Incandescent Lamps.

The question as to the merits of the various systems of lamps now sold being a very important subject, both to the manufacturer and consumer, especially the latter, as there appears to be no reliable data at present which can be relied upon to guide the purchaser in selecting his lamps, perhaps you will permit me to intrude on your valuable space with a few remarks that may tend to bring about a discussion relative to the several points hereinafter mentioned, and thus lead to the desired information being obtained and recorded in the scientific journals for the benefit of those engaged in the development and success of electric lighting, the carrying out of which differs materially in many special cases in consequence of numerous difficulties to be contended with in connection with the incandescent branch of lighting by glow lamps, consequently no "rule of thumb" system can be relied upon to fill all the necessary requirements.

It is only natural that all inventors should consider their own lamps the best, and in some cases for many purposes perhaps it would be so; but circumstances alter cases, and when one type of lamp would be just the thing to suit some particular machinery being used, in another it may be worthless, and not at all suited; hence many failures occur, to prevent which much careful judgment and experience is needed, as upon the lamp greatly depends the success of an installation. It is for this reason that I venture to offer some few remarks and suggestions upon the above, which just now in electrical circles is the leading topic of the day, especially as opinions differ so widely upon this subject. Some engineers will recommend nothing but high resistance lamps, and if you ask them to give you a practical reason, they are unable to give an answer, beyond: "I must have them, because my dynamo is wound for such and such a potential;" whereas others are believers in very low resistance lamps, but attempt extremes. Now it stands to reason one or the other must be wrong, and I prefer to form my own opinion, and would state that I am a believer in the happy medium, and consider a lamp of 30 volts to be the most useful and practical voltage for general purposes, and without doubt the very best and most suitable for domestic lighting; and I am convinced that there is nothing so economical and safe for small installations as a 16 candle-power lamp of low resistance, taking a pressure flow to make it glow of not

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more than 30 volts E.M.F., and absorbing, say, 0·9 ampère of current to fully incandesce it.

My firm has during the past season carried out numerous temporary installations for balls, bazaars, &c., and has installed several 30-light permanent installations, and in each case using our 30 volt standard low resistance lamps, which are working admirably for the purpose. I am therefore able to speak with some authority from practical experience ; and I am certain for small electric light installations of this kind, both for economy in working and outlay of capital, there is nothing to beat a 30 volt lamp being used for this purpose, and to very great advantage in more ways than one; the most important of which is, that there is a difference of 20 per cent. in favour of the 30 volt over the 50 volt being used.

I would also point out that engineers can produce a far better dynamo for the money to run the former, and 10 less accumulators are required ; besides, a smaller gas engine or domestic motor will suffice to do the work ; less space is also required, and last, but not least, even when machinery is entirely dispensed with for generating the current, and one has to resort to the expensive method of charging accumulators for domestic lighting from a primary placed in the garden for this purpose, the saving is very considerable in zinc and acid consumed. Moreover, if a 60 volt dynamo is used in larger installations, better results are obtained even then by running two 30 volt 14 C.P. lamps in series, instead of one 60 volt 20 C.P. lamp in multiple, which in the former case can be used with safety by having a spare shunt lamp, in case of breakage, thus obtaining 8 per cent. more light by this means, which to the consumer is an important item in a small installation.

Having opened up a field for argument, it rests with others to follow suit ; and I would suggest, in order to obtain authentic information, and to ascertain the best all round lamp in the market, that special and reliable information should be obtained and recorded as to "*The Merits and Life of both High and Low resistance Lamps*," and the following points be practically enquired into, and the facts recorded for the benefit of the uniniated who are desirous of knowing :—

1.	The life of lamps	when fed	entirely from	Storage batteries.
2.	Do.	do.	do.	Primary „
3.	Do.	do.	do.	Thermopiles.
4.	Do.	do.	do.	Secondary generators.
5.	Do.	do.	do.	Shunt wound dynamos.
6.	Do.	do.	do.	Compound dynamos.
7.	Do.	do.	do.	Dynamo wound for low E.M.F. with increased out-put in ampères.
8.	Do.	do.	do.	Dynamo wound for just the opposite theory.
9.	Do.	do.	do.	The above tests carried on circuits, say, of 100, 200, 500, 1,000 and 2,000 yards' distance from dynamos, and results recorded.
10.	Do.	do.	do.	The exact C.P. obtained from the lamps at each of above distances.
11.	Do.	do.	do.	The use of high-speed engines.
12.	Do.	do.	do.	Low-speed engines.
13.	Do.	do.	do.	Gas engines.
14.	Do.	do.	do.	Turbines.

15. The life of lamps and results by running lamps 2 and 3 in series of equal voltages over lamps in parallel.

There are many other points I could mention, but the above will suffice for general requirements, as in each case different results will be obtained upon experiment. Under these circumstances, it is important in the interests of electrical science, if possible to find out the reasons, in order to enable engineers to carry out electric light installations with satisfaction and economy combined, for upon these two points depends the future of success of incandescent electric lighting.

Arthur Shippey.

13 and 14, King Street, Cheapside, E.C.,
April 27th, 1886.

New Experiments on Electricity, Heat, and Light.

In my letter to you of the 3rd inst. I produced experimental proof that electricity is a component part of the substance which we call ozone, and I broached the opinion that the flash of light seen by MM. Hautefeuille and Chappius in the glass tube must have been the result of the union of a portion of the extra heat with the electricity which had formed a component part of the ozone prior to the ozone's decomposition, which caused the explosion. To determine the connection between, or rather, the relative positions of electricity and heat, I made the following experiments :—I have a Geissler vacuum tube of the shape of the letter V, each leg of which measures 7½ inches in length, and the outside diameter of it is ¾ of an inch. The platinum terminals being at the upper ends of the letter V. I adjusted this tube so that a powerful current of electricity passed through it from a Ruhmkorff's coil. I noted the amount of light produced within the tube while it was thus in the atmosphere of the room, at a temperature of + 67° Fahr. I then had it placed in a freezing mixture of ice and salt at a temperature of + 5° Fahr. In this position, the light within the tube was greatly diminished. I then had the same tube, with the same arrangement of coil, immersed in boiling water. Immediately, a wonderful effect was produced. There was a greatly increased amount of light within the tube ; a brilliant bluish flame filled both legs of the tube, and also striæ appeared of a very marked kind. As the latter never appeared in the tube when it was not in the boiling water, this leads to the conclusion that the striæ are produced by increments of heat passing through the glass into the interior of the tube.

These experiments establish that the light produced in the tube which MM. Hautefeuille and Chappius saw must have been the result of the union of the heat and electricity within the tube ; and further, these experiments lead to the conclusion that if we could place the V Giessler tube, or an incandescent electric lamp, in an atmosphere void of heat no light would be seen in them, although a powerful current of electricity were passed through them.

James Johnstone.

8, Merchiston Park, Edinburgh,
April 27th, 1886.

Prof. Hughes on Self-Induction.

I have noticed several criticisms upon my paper upon self-induction, most of which have appeared in your valuable journal, and I believe they all require a few remarks in reply.

The criticisms may be divided into three classes :—

1st. Prof. H. F. Weber shows that the method which I employed admits of numerous errors, and consequently infers that the results which I have announced are due to an " incorrect interpretation."

2. Mr. Oliver Heaviside points out that upon a close examination it will be found that all the effects which I have described are well known to mathematicians, and consequently old.

3. Mr. Willoughby Smith points out that the results which I have announced are contrary to theory and practice, and experimentally demonstrates that he is unable to obtain any difference even between iron and copper.

I must say that I am unable to agree with these opposing views, for if we assume with Mr. Heaviside that all my results are contained in some mathematical formula of which I am unaware, then the mathematicians ought to feel extremely grateful for the experimental proof with which I have furnished them; if, on the other hand, we agree with Mr. Willoughby Smith, then

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the formula and my results should at once be abandoned as experimentally untrue.

Prof. Weber's objection is more serious, and I fully admit that it is possible to make very serious errors if the sonometer is not calibrated, or if we do not appreciate the errors that can be easily introduced. I feel sure that Prof. Weber could have seen how such errors could have been avoided, and this even by several means that I have indicated, such as making comparative tests between wires of the same length and resistance so that no change took place in the bridge adjustment except that due to the differential results.

The only question which I consider important is, Are the effects which I announced true physical effects due to the nature or form of the conductor, or are they simply due to some peculiarity of the method which I employed? To answer this I have constructed an instrument based upon an entirely different method, one of extreme simplicity, and one which does not allow of any possible error.

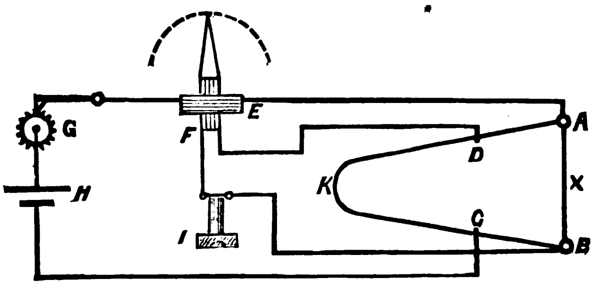
I propose to publish a description of this instrument (together with the results obtained) during the coming month, when I hope that its demonstrations will prove clearly all that I have said as to the influence of the form as well as the nature of the conductor upon its self-induction.

D. E. Hughes.

There are one or two points in Prof. Hughes's address which seem to have been little dwelt upon in the discussion.

In the use of a telephone instead of a galvanometer in such a null method the telephone will not necessarily be silent even when the galvanometer shows no deflection. For a galvanometer to show no deflection it is only necessary that $\int t\, d\, e = \int t\, d\, e'$ where e is the counter E of induction in the wire under test and e' the E of the secondary coil of the sonometer, but for a telephone $\frac{de}{dt}$ must $= \frac{de'}{dt}$. I would suggest, with great diffidence, for Prof. Hughes has most likely thought the matter out very much more thoroughly, that the primary coil, E, of the sonometer should be inserted between C and B, so that its rise of current is the same as that of the wire under test.

If the coil would be itself objectionable there, the result might be obtained by making the resistances, C D, D A, practically infinite compared to C B, B A.



Another method would seem to be replacing C D by a duplicate of the wire under test; if C B and D A have no self induction this would seem to give the conditions of silence. As the current in x is then always half of that in E, their rate of increase at any instant is the same.

Though it has been mentioned since, none of the speakers noticed that the induction of the sonometer is only proportional to the angle when that angle is infinitely small; might it not be calibrated by using different lengths of a wire in A B, or A B and C D?

There seems to be something anomalous in the behaviour of glow lamps with alternating currents. Thinking that the resistance of carbon might depend on the current density, I had some experiments tried to see, but the results were conflicting. In July, 1884, Mr. Ram carried out several for me. If the resistance of carbon remains practically constant through a good range of temperature, as it appears to do with a direct current and a reasonable brightness, one would expect that a lamp which gives a certain light with a direct current and a certain current dynamometer reading, would give the same light with a smaller reading with an alternating current, for the light of a lamp is not as the power. One would further expect that the thinner the carbon, or the slower the alternations, the greater the discrepancy would be. Instead of this, Mr. Ram found that, of several lamps running at the efficiency of ·3 *c p w* on a direct current, the mean square reading with an alternating current, was from 7 to 13 per cent. more. This would seem to show that the resistance falls with a large current density; but further experiments by other methods did not confirm this view at all. By resistance I mean not opposing electromotive force due to rising current, but resistance.

Profs. Ayrton and Perry make slips so seldom that they will be glad if I point out that they could not expect a lamp to give the same readings with alternations of different period; as for such a result the carbon must either have no mass or no specific heat. A lamp will, of course, burn brighter with the same mean square current reading and slow alternations; and it is not necessary to assume enormous self-induction in the dynamometers to account for this. Local currents, of course, do not affect the reading of the dynamometer. If carbon behaves anomalously under alternating currents, it is possible that it interfered with the accuracy of M. Joubert's researches in dynamos.

Surely there is no need to call counter electromotive force resistance even when it is due to self-induction and causes Prof. Forbes's local eddies. For instance, Profs. Ayrton and Perry have gone to considerable trouble to show that these local currents produce resistance. Would it not be far simpler to say that if you have a current through a lot of conductors in parallel, and you put counter E into some or all of them, more external E is needed to keep the total current constant?

Jas. Swinburne.

The recent revelations made by Prof. Hughes on the above subject have undoubtedly taken the scientific world by surprise, apparently, the more so, inasmuch as both physicists and electricians are making of it the scientific theme of the day.

Such disclosures, made by such an authority on the subject as Prof. Hughes, have a great weight in the scientific scale, consequently it is not surprising, but only natural, that they should excite keen comment and criticism, considering that if time and further researches should prove them to be correct it would necessitate, if not a radical reform, at least a thorough amendment, of some of the universally accepted laws on electro-dynamics.

Meanwhile Prof. Hughes can afford to listen calmly to the scientific debate, and await with comfort for the final verdict, knowing, as everybody does, that truths, like facts, may be temporarily eclipsed, submerged, and defeated, but at the end they ultimately rise as victors.

It may not be inopportune or uninteresting to quote here the substance of Prof. Hughes's abstract paper, read as his inaugural address on the 28th of January, before the Society of Telegraph-Engineers, on the occasion of his election as president of the said society. After describing the ingenious apparatus which served for his researches on self-induction (which consist of a Wheatstone bridge, intersected in the diagonals by the two concentric coils of a sonometer, connecting in one a battery and an automatic make-and-break, and in the other a telephone in place of the galvanometer, as in the ordinary bridge), he proceeded to describe his experiments, drawing contemporaneously from them the following conclusions and statements in

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regard to the inductive capacity of metallic conductors traversed by intermittent currents. He said :—

"In a metallic straight conductor the force and duration of the extra currents varies :—

"1. With the kind of metal with which it is made.

"2. With its molecular condition or physical state.

"3. With its sectional area and form, independent of its resistance or the electromotive force of the primary current.

"4. The time of charge and discharge of the wire is independent of the electromotive force of the extra currents ; but increases rapidly with the section.

"5. With a constant length the electromotive force of the extra currents increases with the section (but not in an equal ratio except in soft iron) up to a limited maximum point, from whence it varies indirectly with the section, this maximum point varying with different metals.

"6. (Probably) with non-magnetic metals, the greater the specific resistance of the metal, the higher the maximum point (relatively to its diameter) before the reversal takes place.

"7. The form of a conductor has more influence on its self-induction than its resistance or even the nature of its metal.

"8. In a metallic straight conductor, the electrical resistance is greater during the 'variable' than the 'stable' period of the current.

"9. With fine wires and powerful currents the effect is reversed, *i.e.*, the electrical resistance is greater in the stable than in the variable period.

"10. The reaction of two parallel return wires varies more with the nature of the metal than upon the proximity of the wires.

"11. Some metals whose self-induction is high in a straight-formed conductor, when formed into coils becomes low ; whereas the reverse happens with those whose self-induction is low in a straight-formed conductor.

"12. In parallel return wires, the force of extra currents is less than in straight wires.

"13. In short wires the duration of extra currents is exceedingly small.

"14. The self-induction of a conductor is greatly diminished by subdividing the same in several small conductors or streamlets.

"15. For a single conductor, the worst possible form is the circular section ; the best being the ribbon form, thin and wide.

"16. Currents in copper wires are far more influenced by an external wire than those in iron.

"17. In a solid bi-metal conductor the self-induction is less than in a mono-metal conductor having the same stable resistance and sectional form ; this being due to the difference of electromotive force of the extra currents in the two metals, each mutually reacting as shunts upon one another."

It would be rash to accept all these statements as future laws in electro-dynamics simply on the authority of one man (no matter how great that authority might be) without at least repeating the same experiments by different methods, and by a plurality of observers, in order to effect a reliable check of the results of each experiment and method. Anyone who has had anything to do in these sort of experiments knows very well that if accurate testing is to be the aim, nothing but independent tests, made under a multiplicity of conditions, can lead to the true value ; for, as it has been proved before, in so complex a field as that of electro-magnetic induction, where one effect easily reacts and influences the other, and *vice versâ*, the possibility of errors is ever there, and may often baffle the closest attention of the keenest observer. One need only compare the different results obtained by independent experimenters on the determination of the electrical standard of resistance in absolute units, and compare them also with the results obtained by the committee appointed by the British Association for the Advancement of Science in 1862, for to convince himself how far true the above remarks are.

When laws of nature are in question, it is rash and futile to attempt to confute the results of a series of experiments by the simple substitution of a few mathematical expressions, such as has been done by Prof. Weber, of Zurich, in *La Lumière Electrique* and the ELECTRICAL REVIEW.

For example, let us try to examine some of the most startling points in Prof. Hughes's paper, and see how far they differ from known laws. Taking 1 and 2, we see them at once to be in contradiction with accepted laws, although I may say, from my own experience, I have often been led to believe, in at least between copper and German silver wire, there was some difference in their self-inductive capacity ; but in what degree I have never been able to ascertain. The following description, I trust, will not be inopportune, inasmuch as it serves to illustrate the point.

Some few years back I happened to make some copper standards of resistance, reproducing them from one B.A.U. in platinum-silver.

My bridge consisted of two German silver arms, with an intermediate balancing wire of the same alloy. On the opposite side it formed the quadrilateral by the unknown copper coil and the platinum-silver standard ; all the coils being neutrally wound. A battery, a double key, and a reflecting galvanometer completed the diagonal circuits. After a few preliminary adjustments with the first copper coil, I soon came to a point where I encountered some difficulties in ascertaining the true temperature of it, in consequence of the prolonged time that elapsed between putting the battery in circuit and the time required for the bridge to return to stability before the galvanometer could be put in circuit, or unshunted as the case might be. To reduce the heating of the wire as much as possible I resolved to reduce the strength of the battery, making up for this by an increase of sensibility in the galvanometer.

With this view I constructed a special needle with the least possible inertia, whilst retaining as much as possible its magnetic moment. Although I found this to be a step in the right direction, yet the results still left a great deal to be desired. As a next resource I made the final adjustment whilst keeping the galvanometer in circuit and unshunted. As was to be expected I soon discovered that to do so was almost an impossibility, owing to the strong extra currents prevailing in the bridge at the moment the battery was put in circuit, which threw the spot from left to right as the case might be, and made in consequence any reading impossible.

Thinking this phenomena might be due to magnetic effect, I wound several coils of different sized wires and stranded some before winding, but uselessly ; they all gave more or less the same result. Strange to say, if I substituted either a German silver or a platinum-silver coil no such disturbance took place. Since then I have always regarded copper as by far a greater favourite for extra currents than German silver or platinum-silver. I thought at times that this disturbance might be neutralised by means of an automatic commutator intersecting the diagonals, but never carried the idea into practice.

It was for the learned professor to be illuminated with the beautiful idea of intersecting the same by means of his sonometer ; he has by this means given to the world a very useful instrument, for which "Time" will not fail to redound it to his credit.

Whether the self-induction is measured directly by the V of the inner coil is a matter of no great moment, as it will not be long before mathematicians find out what is the correct function on which it depends.

As for (3) this was already known, except in so far as the electromotive force of the extra currents was thought to vary inversely with the section. As for the maximum inductive point as mentioned in (5) it is at least, to my limited faculty of perception, a great "puzzle." In regard to the increase of resistance (8) in the variable period it is very difficult to form a definite opinion, since as in the case of non-magnetic metals and alloys it remains still a doubt (until further researches are made) whether it is due to a purely molecular resistance, or whether it is, instead (as most

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probably), due to an opposite electromotive force of the previous extra current, of which the primary current has to encounter and clear itself at every alternation.

It would be idle to imagine (14) a material gain by subdividing telegraph and telephone wires simply for the sole purpose of diminishing self-induction, considering, as would be the case (apart from creating an inconvenience by the multiplicity of wires on poles) the great drawback in consequence of a probable increase of mutual induction between one line with the other. As for the possibility of adapting the same subdivisions in wires on coils for any particular purpose, the advantage which would be derived would hardly (in my humble opinion) compensate for the loss in effect of the current upon a given point, in consequence of a decidedly increased bulk in the bobbin, in which the mean centre of the currents would be more separated from the centre of the coil.

Ultimately for bi-metallic conductors (17) should they prove to be correct, it will be a great gain in rapid telegraphy and telephony, and perhaps it will tend to clear up some of the mysteries enveloping the extraordinary results obtained in long distance telephoning, with compound wires, as was the case only a few years back with the 1,000 miles telephoning between New York and Chicago.

A. E. Conti.

Charlton, *April 20th*, 1886.

Two Polar v. Multipolar Dynamos.

I should feel obliged if those of your readers who have had practical experience with dynamo machines would mention the advantages and disadvantages which they have found with the above two forms of machines, and give their opinion as to which form is the most efficient commercially. There seems to be a great diversity of opinion on this subject; some say that the fewer poles there are in a machine the better, others that many poles give the best results.

In support of the latter, I would mention the case of the Victoria dynamo. In the discussion following Professor Sylvanus Thompson's paper on "Recent Progress in Dynamo-Electric Machines," read before the Society of Arts, February 28th, 1884, Mr. Percy Sellon said that, taking an original Schuckert machine, capable of giving 60 incandescent lamps of a certain power, by substituting four poles for two, the mass of which, both in iron and in copper, was very little in excess of that in the original two, and using identically the same ring, they obtained 100 lights, and a much better result in the commutator. He also said that, in constructing large dynamos, they were increasing the number of poles to six and eight, and, eventually probably, they would go to twelve for very large machines. Then again, the Gülcher dynamos have four and six poles; and the larger Elwell-Parker machines have four poles.

But, on the other hand, there are the two polar machines of Gramme, Elwell-Parker, Kapp, Crompton, Joel, the Phœnix, and many others; so that, if anything is to be adduced from numbers, makers are decidedly in favour of two pole machines. In most of these the armatures take the form of the elongated or cylindrical Gramme ring. I do not know whether this is the reason of their having only two poles.

There is also one other subject about which I should be glad to receive some information.

The following is quoted from Professor Thompson's paper already referred to:—"It is a singular result that, while in those machines in which the ring armature is extended cylinderwise, there must be wide embracing pole pieces; in those in which the ring is flattened into a disc shape the pole pieces must on no account be wide." Now, does this refer to two polar dynamos with flattened ring armatures, or only to multipolar machines of this type? I have heard it said that it only refers to the latter; is this so, and why?

I trust you will excuse my occupying so much of your valuable space, but I believe this subject will be of interest to many.

W. E. Hayne.

April 20th, 1886.

Dynamo Tests.

In your last issue you call attention to certain discrepancies between the indicated and electrical horse-powers as shown in Table VI., and call for some explanation of them.

You will notice that the report states that there was great difficulty in keeping the speed uniform when running without governors and with boilers too small for the work.

No doubt these sudden fluctuations are the cause of the apparent discrepancies, as although great care was taken to get simultaneous readings, in some cases the indicator cards were taken a few seconds later than the electrical readings.

But the main fact remains that a certain quantity of water was accurately weighed into the boilers, and from this quantity a net electrical output was obtained at the rate of 1 electrical horse-power hour for each 31·5 lbs. of water evaporated.

We cannot see how any discrepancies such as those you have called attention to can in any way affect the accuracy of the economical results obtained as above.

Those who conducted the trials have satisfied themselves that the figures are published exactly as obtained —without any alteration or rounding off whatever.

We believe that by publishing these results exactly as obtained we are serving the best interests of students and others interested in these matters.

R. E. Crompton & Co.

Chelmsford, *April 20th*, 1886.

Telephoning between Ship and Shore.

As I see several communications in your valuable paper with regard to connecting up ships by telephone, the following may prove of interest.

In 1883-1885, when I was in charge at Mauritius for the Oriental Telephone Company, I used regularly twice a month to connect up the Messageries Maritimes mail steamers with the Exchange at Port Louis.

The wire was run to the side of the harbour and there connected to a cable 300 yards long; the end of the cable was attached to a buoy, and a lead taken from it into the steamer.

This worked fairly well for a time, but the cable was always getting into trouble through ships' anchors, &c., so I employed a light cable, which was run out on the arrival of the mail and taken up on her departure.

This answered very well, and was working when I left.

Besides the mails I also connected a line of steamers from Bombay, and sometimes have had two ships at once connected by switches on to the line, with as much as 600 yards of cable out.

Harold Dowson.

30, Rendezvous Street, Folkestone,
April 23rd, 1886.

Economy in Electrical Conductors.

Would one of your many correspondents explain how Profs. Ayrton and Perry obtain the expression (the 2nd term),

$$c^2 r + \frac{t}{r},$$

which is used in their paper, published in your number for March 19th, under "Proceedings of Societies."

E. O. W.

April 21st, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

Vol. XVIII.—No. 441.

THE COLONIAL AND INDIAN EXHIBITION.

The inaugural ceremony of this, the last and greatest of the series of South Kensington exhibitions, is proceeding whilst these lines are being penned. We say the greatest advisedly, for although last year's Inventions Exhibition contained more of purely technical interest than the present one, the fact cannot be overlooked that considerations of vastly greater imperial importance are involved in this gathering together of the peoples and products of the whole range of English colonies and dependencies. The fraternal interchange of ideas and the personal intercourse of the natives of widely-separated lands who all own allegiance to one Sovereign Lady, are something more than little-meaning accidents of circumstance, provoking sentiments entertained but for the moment and forgotten or set aside in the aftertime: they are the basis of a deeper, truer loyalty and attachment to the English Crown and nation, the effects of which will become more and more obvious as the years pass on. Those effects, we feel sure, will be not only increased interest in all that pertains to England and to England's Queen, but something more substantial and practical, sturdy support, throughout the British realm, of English national principles, and extension of English commerce. Despite the sneers of other nations and the temptations afforded by precedent to total separation from the mother country, those of our colonies the farthest removed by distance have quite recently shown that they are prepared to do and dare a great deal for Old England; and when the representative men of these and the other colonies find how strong and active here at home is the feeling towards our distant brethren, the bonds uniting us with them can only be drawn the closer. We hail the opening of the Colonial Exhibition as the marking of a distinct epoch in the history of the relations of the various constituents of this great Empire, as the celebration of a period when the colonies were tried and did not fail us.

But a word as to the management of the Exhibition. The doings of the comparatively few people upon whom has devolved the active portion of the arrangements of the past three exhibitions have not given unqualified satisfaction: light is sought to make it quite clear whether private ends have not been made paramount to fair dealing. Arbitrary to the point almost of despotism as has sometimes been the conduct of the ruling authorities within the Exhibition gates, we shall be very reluctant to believe that any great breach of moral honesty has been committed. But their proceedings have been by far too secret, and it is not unreasonable to ask that, for the satisfaction of the public, greater publicity to matters financial, and in fact to all matters relating to the general management, shall be given in regard to the Exhibition just opened. It seems of little use to ask, for it has been asked and not answered, what has become of the large surplus profit on the Health Exhibition, and in what way the deficit arose on the Inventions Exhibition; and although we ask for more openness now we are not at all confident that it will be accorded. This is the unpleasant and unsatisfactory aspect of the Exhibitions which, we admit, have given pleasure and profit to many thousands; it is to be hoped nothing more unsatisfactory may yet occur.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

By CARL HERING.

IV.—Series Machines.

Let it be required to wind the magnets to make it a series machine.

It is evident that this will be much simpler than in the shunt machines, for having given the ampère windings and the ampères, there is no alternative but to make the number of windings $\frac{(a\ w)}{a}$. A few hints, however, in regard to the details may lead to a better proportioning of the parts, and to results which, under the conditions, are the best possible. We will also show how the machine may be regulated for a varying number of lamps.

It is evident that in series machines there is a loss of potential in the current, as it passes through the magnet coils. As the current is the same in the whole circuit, the loss of potential will represent the proportion of power lost in the magnets. This, as with the current in the shunt machine, may be taken at 1·5 to 2·5 per cent. of the total for large machines, and 10 per cent., or even more, for small or cheap machines.

Proceed with the test for determining the ampère windings, the same as described for shunt machines, but in this case excite the field magnets until the desired current delivered by the machine has the required potential *plus* that which will ultimately be used up in the magnets, that is, the required potential for the lamps and leads, *plus* 1·5 to 2·5 per cent. (as the case may be) of this potential, the current strength remaining the same. Call the quantity of ampère windings found in this way (a w).

Continue the test to determine the magnetism curve in the same way as before in order to see whether the machine is properly proportioned, and if not, how to find its proper proportions; also to see whether the machine can be used for more lamps or whether it is overworked.

Having given (a w), and as the whole current passes around the magnets, the number of windings will be

$$\text{W} = \frac{(a\ \text{W})}{a}.$$

It remains now to so select the wire that the loss of potential in the coils shall not exceed the allowable amount; that the coils may be wound full, for the sake of appearance; and that the wire will not heat too much.

The resistance of the coils will be, as stated in considering shunt machines,

$$\text{R} = 50{\cdot}13\ \frac{\text{W}\ l_m\ \theta}{d^2}$$

in which

R is the resistance of all the magnets in legal ohms.

B

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W, the total number of windings on all the magnets.
l_m, the average length of one winding, in inches.
d, the diameter of bare wire in mils.
θ, the specific resistance (metric) at the allowable temperature of the magnet coils.

The current being a, and letting the allowable fall of potential in volts be represented by v, the resistance will also be, from Ohm's law,

$$R = \frac{v}{a}$$

Combining these two and finding the value of the diameter, gives as before

$$d = \sqrt{\frac{50 \cdot 13 \ (a \ W) \ l_m \ \theta}{v}}$$

with this difference, that v represents the allowable loss of potential in the magnets, and not the potential at the poles of the machine, as in the case of the shunt machines.

In regard to the mean length, l_m, for an assumed thickness, c, of a coil, the same that was said before, applies to this case as well.

The precautions required for calculating the diameter, d, for shunt machines, in order that the resistance shall not be too large to take the current, are evidently not necessary in this case, for the whole current is compelled to go through the magnet coils. If the resistance should be a little too high, it will only reduce the efficiency of the machine, but will not prevent its working, as it would in case of shunt machines. The factor of safety referred to may therefore either be safely omitted, or may be taken smaller than before. The latter is preferable, as it is always more satisfactory to the constructor to have the final results turn out to be inside of the limit placed than beyond it.

The factor of self-induction in the coils, which acts to apparently increase the resistance, is probably the most important to allow for in this factor of safety. It is difficult to say what to allow for it, as it depends on so many quantities, such as the number of windings, the number of commutator strips on the armature, the speed of rotation, the current in the coils and the nature of the iron. For ordinary machines we suppose 5 to 10 per cent. will be a sufficient factor of safety to cover all these. Instead of introducing the value of v directly into the formula, we therefore take 95 to 90 per cent. of v.

Taking, as before, the value of θ equal to ·0162, and assuming a temperature of 70° F., the formula becomes

$$d = \sqrt{\frac{\cdot 875 \ (a \ W) \ l_m}{v}}$$

in which d is in mils., l_m in inches, and v the allowable loss of potential in volts, which should be first reduced as above described, to include the factor of safety.

But this may give a diameter which is so small that the wire will heat, which will be the case if the magnets or the ampère windings are small or if the allowable fall of potential be large. In that case, the diameter will have to be determined by the heating effect, and not by the allowable resistance. It is necessary, therefore, to calculate the proper diameter from both the above formula and the heating effect, and then take the larger value of the two. For the heating effect it is safe to take ·001 ampère per square mil of cross section of wire, which is equal to 1,000 ampères per square inch. This figure, as will be noticed, is smaller than that given for shunt machines, for in the latter the wire being smaller, it will cool off more rapidly. For large, compactly-wound magnets, however, the difference in cooling of large and small wires will not be great, so that both this constant and the other may be varied slightly.

Having found the two values of d, and chosen the largest, take the nearest gauge number or size, to this value, and find its diameter, d_1, outside of the insulation. Having given the number of magnets and the length of one magnet core, e, we can now determine the number of windings per layer from our formula—

$$\frac{1{,}000 \ e}{d_1}$$

in which e is the length of a core in inches, and d_1 the external diameter of the wire in mils.

The number of layers will in this case have to be calculated from the number of windings, and not, as in the shunt machine, from the allowable thickness of coil c; for in this case the value of W is determined at the outset by the current, a, and the ampère turns (a W), and there is no deviation from it.

The thickness, c, must therefore be calculated from W as follows: Let n be the number of magnets, then the turns per magnet will be $\frac{W}{n}$, and the number of layers will be

$$\frac{W}{n} \times \frac{d_1}{1000 \ e}$$

from which the thickness, c, can be readily calculated

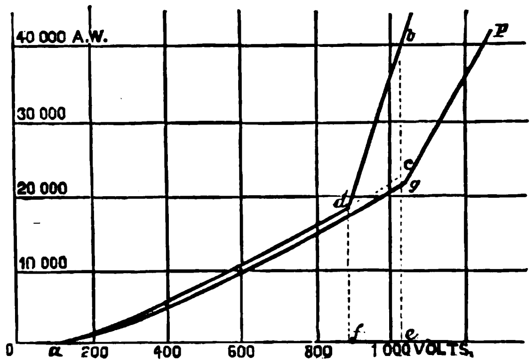

FIG. 2.

by multiplying this by d_1 and reducing to inches. It can be calculated directly from the formula—

$$c = \frac{W \ d_1^2}{1{,}000{,}000 \ e \ n}.$$

If this is about the same thickness as that which was assumed, then, provided the wire does not heat, and that the magnets are not over saturated, the machine is properly proportioned, and there remains only to calculate the resistance or fall of potential as a check, and perhaps to alter some parts slightly for the sake of the appearance of the magnets; that is, that they may be wrapped full. This will be described later.

If this calculated value of the thickness, c, is found to be much smaller than the assumed thickness, and if it is found from the magnetism curve, as described in the beginning of these articles, that the magnets are just saturated, then it shows that the magnets are too long, and they may be advantageously shortened. The cores may be shortened to such an extent that for the same ampère turns and diameter of wire, the thickness of coil c is about that which was above assumed; that is, the length, e, of a magnet, in inches, may be made,

$$e = \frac{W \ d^2}{1{,}000{,}000 \ n \ c}.$$

If, on the other hand, the thickness found from the formula is much larger, and the magnets are just saturated, it shows that the magnet cores are too short, and they should be lengthened to the amount required by the formula just given.

If the magnets are very much over saturated, then it only remains either to use the machine uneconomically or to use it for less lamps, or to increase the size of the core so that from the magnetic curve the magnets are seen to be just saturated. For instance, from the magnetic curve find at what point, that is, for what ampère windings, the magnets are saturated. Divide this by the number of magnets, and then by the cross section of a core in square inches; this gives the saturation coefficient, or the allowable ampère windings per square inch of magnet core, for that shape of core and for that

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quality of iron. Having determined this constant, it is easy to calculate what the size of core should be in order not to be over saturated, for that quantity of ampère turns, which this particular machine requires. If m is this allowable density of magnetism, the required cross section in inches should be

$$\frac{(a\ \text{w})}{m\ n}.$$

But this will do only for a slight increase or decrease, as it is only approximately correct, and it may, for an increase in core, be safely taken a trifle smaller, because, when the core is increased in cross section, it will no more take the same number of ampère windings to produce the same amount of magnetism than when it was over-saturated as it was in determining the ampère turns. It will also require less ampère windings to generate the same magnetism, for the reason that the same current passing through a coil with a larger core, but with the same ampère turns, will produce more magnetism in proportion to its linear dimensions, and therefore will require less ampère windings to produce the same magnetism. This can be demonstrated as follows :—In a single winding, the intensity of magnetism produced by a certain current is less in proportion as the diameter is increased ; that is, for twice the diameter it is half as great; but the total magnetism is proportional to the intensity and the area, and is, therefore, proportional to the linear dimension, because the area increases as the square of the diameter and the intensity inversely as the diameter; therefore the total number of lines of force will increase as the diameter. For instance, if the diameter of a coil is doubled, the intensity will be halved, but as the area inclosed is four times as great, the total magnetism, being the intensity multiplied by the area, is twice as large.

For this reason, and because there will be less ampère turns required in the new cores when they are not over-saturated, it will be better, when the increase is comparatively great, to determine the new cross section more accurately than by the first method, by proceeding as follows :—

Take the curve of magnetism, a, b (fig. 2), below the saturation point, d, and continue it with about the same rate of curvature beyond the point, d, where it takes a decidedly different direction. This will then be approximately the curve which the machine would have if the magnets were not saturated, but at the same time, if the area of core were the same. Through this new curve drop a perpendicular, b, e (representing the magnetisation), on to the line, o, e, through the point, b, at which the machine was tested, then the point, c, where this line intersects the new curve, will give the ampère windings represented by c, e, which would be required on the new machine to produce the same magnetisation if the cores were not saturated and if they were of the same size. Call this number of ampère turns (a w′) represented by the length of the line, c, e ; call the distance, d, f (a w″), and let the required number of ampère windings of the new machine with larger cores be (a w) ; then

$$(a\ \text{w}) = \sqrt[3]{(a\ \text{w}')^2\ (a\ \text{w}'')};$$

thus giving the required number of ampère windings directly. The deduction of this formula would not be in place in this article ; it is sufficient to say here that it represents that number of ampère windings which will be required by a larger core, to generate the same total number of lines of force, at the same allowable density of magnetisation (or coefficient of saturation), and considering the fact that the larger the area of the core the less the ampère windings. The application of the formula will be illustrated later by an example.

Having determined the number of ampere windings, find the new cross section of core by dividing it by the number of magnets and the coefficient of saturation obtained from (a w″) and the area of the old cores.

If the core, in the original machine, is found to be very far from being saturated, the magnets are unnecessarily large in cross section, and they may be diminished in a similar way as above described.

Having now determined the proper cross section of the core for the new machine, calculate from the new number of ampère windings (a w) what the diameter of wire should be, and from this as before, the thickness, c. This is then the thickness required when the new magnets are just saturated, and if this is much larger or smaller than the new assumed thickness, it shows that the magnet cores are too short or too long, as above described. The new length may be determined directly, without first calculating c, by the formula previously given.

If the curve of magnetisation is found to be a regularly curving line without an abrupt change of curvature, it shows that the iron is not well distributed in the machine or that it is very hard. It shows that it does not saturate all at once, as it should, but that at some parts it is too small in cross section, so that they saturate sooner than other parts. But this is a subject to be treated by itself, as it cannot be discussed here ; it is sufficient to say here that all the parts of the complete circuit of the lines of force should have the same degree of magnetisation throughout the machine ; if they have not, then some parts are too large or some too small. If the iron is soft and the curve does not show one decided point of saturation and only one, there are no doubt some wrong proportions in the sizes of the iron masses. There is no harm in having too much iron at any point, only that it makes the machine uselessly heavy, and therefore not of the most economical proportions.

If the curve shows no decided point of saturation and it cannot be discovered where the weak point in the magnetic circuit lies, then the magnetisation may be continued up to what seems from the curve to be the limit of economical magnetism, or for cast iron oval magnets, up to about 240 to 250 ampère turns per square inch of core.

THE EDISON "PHONOPLEX" OR "WAY-DUPLEX."

WHILE the duplexing of through telegraph lines is now an easy matter and largely applied, the problem of increasing the capacity of lines employed in way service, such as upon railroads, says the *Electrical World*, has up to the present received no satisfactory solution. The ordinary duplex requires a fixed condition of the line, and when that varies even slightly it must be compensated for. Evidently, with twenty or thirty stations on a railroad line, or ordinary way offices, the communication with each office on the usual duplex plan would require a separate balancing for each one, and as one office is called up after another there would be a constant changing and loss of time. Besides, the ordinary duplex would not permit of two independent offices communicating with one or two other offices, and hence its value would be greatly restricted ; indeed, its successful application would be well nigh impossible.

With these drawbacks in mind, Mr. Edison has devised a most ingenious method of doubling the capacity of telegraph lines, whether employed on way business or through traffic.

The name which he has given to the system, the "Phonoplex," or "Way-Duplex," suggests immediately an application of the telephone, and such is indeed the case.

While Mr. Edison's method of working is analogous to that of Van Rysselberghe in his system of simultaneous telegraphy and telephony over the same wire, he, nevertheless, has an entirely different object in view, and that is, to convert the telephone on the circuit into a sounder, so that the regular Morse can be read from it.

Before entering into a description of the details, it may be well to give a short outline of the principle employed.

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It is well known that if the emission and extinction of the current in the telephone be gradual, the diaphragm will be merely bent, and will return to its original form without emitting a sound. But if the make and break in the current be rapid, the telephone diaphragm will "snap," and so give forth audible sound. If now there are included in the same circuit a telegraph relay and a telephone, we may, by manipulating a key, operate the relay (and sounder) without producing a sound in the telephone, as the makes and breaks at the key are too gradual. But if through the same circuit we send the rapid discharge current from the secondary of an induction coil, or the extra current from a primary, it will cause a loud click in the telephone, but the current is too weak to affect the telegraph relay. Hence, by sending two kinds of currents over the wire, we obtain two effects which can be readily utilised for the purpose above described.

There are of course several points which must be observed in practice, and these have been well worked out, as will be seen in the diagram, fig. 1, which represents the equipment and arrangement of circuits in each office. The whole may for convenience be divided into the Morse and the "Phone" branch, although in by the condenser, C′, which is placed there for that object. This intense and rapid extra current does not affect the relays on the line, but passing through the condenser, C, acts powerfully on the diaphragms of the phones, and gives a violent motion to the snapper, P.

It will be noticed that every movement of the lever of the relay, R′, sends two impulses over the line—one on breaking the circuit and another on making at the front stop. The extra current produced by the latter, however, is greatly diminished by the resistance, R″, and follows so quickly upon the first that there is but one click heard in the phone. When the armature lever of the relay, R′, is released by the raising of K′, the reverse operation takes place, for we then have first a weak extra current over the line followed by a stronger one. This change in the order of the currents causes a difference in the sound emitted by the phone, just as in the ordinary sounder the sound of the front stroke differs from that of the back stroke. In this way the signals received in the phone can be clearly distinguished.

Thus far we have supposed that the Morse operator is not working. From what has gone before, however, it is evident that it makes no difference whether his

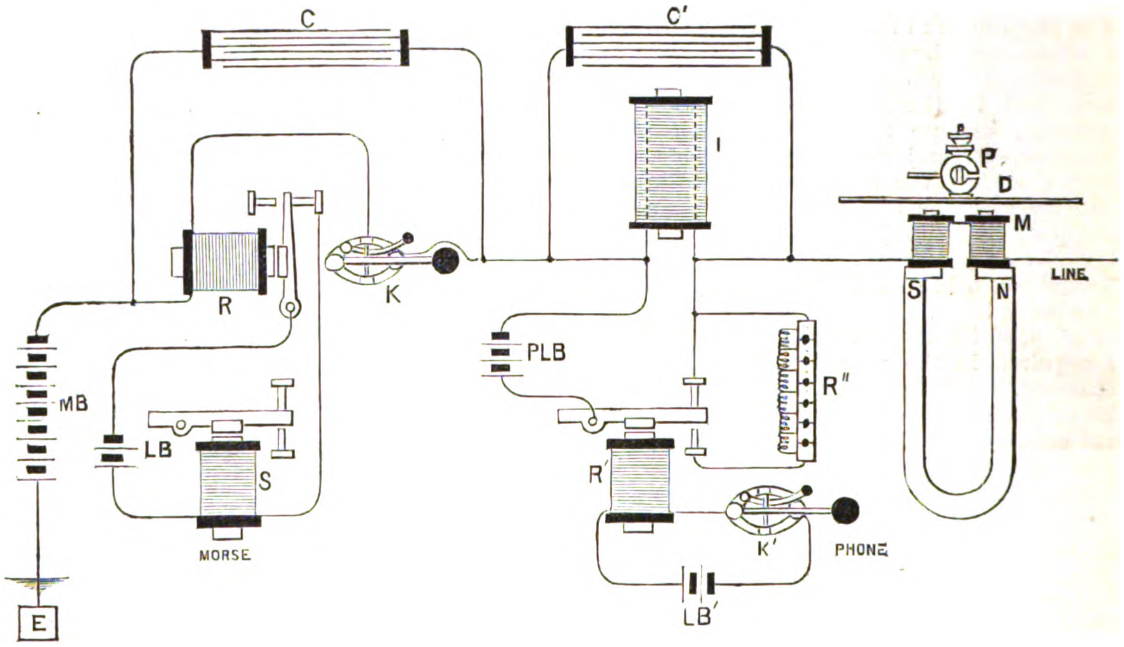

FIG. 1.

reality there is no branch, as in the ordinary duplex—the line being continuous through both.

The Morse circuit at the left consists of the ordinary relay, R, sounder, S, and key, K. In addition, however, there is a condenser, C, placed as a shunt around the relay and key, the function of which will appear presently.

The "phone" circuit shown at the right contains the phone-sounder, with permanent magnet, M, diaphragm, D, and will be described more in detail below. The phone local battery, P, L, B, is in circuit with the primary coil, I, which is always included in the line circuit, and also has a condenser, C′, connected to its terminals. The circuit coming from one terminal of the coil, I, is split, one branch going directly to the back stop of the relay, R′, and the other to the front stop, but including a variable resistance, R″. The phone operator manipulates the key, K′, as usual.

For the sake of clearness, we will suppose that the Morse circuit is not at work. The circuit would then be from line through the phone, thence through coil, I, through key, K, relay, R, battery and earth. But in addition the current has a by-pass through the condenser, C. Now, when the phone operator closes his key, K′, the lever of the relay, R′, breaks the circuit of the primary coil, I, and the intense extra current of short duration is sent over the line. The effect of the extra current and the rapidity of discharge is still further increased key is closed or not, as the condenser, C, is all sufficient for the transmission of the high potential phone current.

In addition to the gradual emission of the Morse current which the operator's key produces, there is also added thereto the retarding influences of the relays in circuit and the primary coils, I, which then have the same functions as when applied to the Van Rysselberghe system, in which they act as "graduators." While offering no reduction in speed to the Morse working, they "graduate" the emission of Morse currents so that they merely deflect the diaphragms of the "phones" without snapping them and producing a sound.

Though a variable resistance, R″, is used, it is merely for the purpose of varying the sound in the "phone" to suit the operator's ear, and once set is never disturbed.

The "phone" itself is a simple and ingenious apparatus, and is shown in section in fig. 2. Resting upon a wooden base is a hollow column of brass, within which is placed a magnet with the bobbins facing the diaphragm. At the lower end of the magnet there is a rack and pinion, by which it can be adjusted with reference to the diaphragm. To the centre of the latter there is attached a screw-threaded pin, with thumb nut and binder at the top. Encircling the pin loosely is a split-hardened steel ring which rests upon

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the diaphragm. When the latter is snapped by the attraction of the momentary current in the magnet, it throws the ring violently against the stop-nuts, and produces a sharp click, far louder than that from the ordinary sounder. The steel ring has a pin projecting from its side that passes between two prongs, which, while permitting free up and down motion, prevent the ring from turning and altering the sound. Over the top of the "phone" there is clamped a thin brass plate as a protection for the projecting screw.

This phonoplex system is especially valuable for railway telegraphy, but is equally well adapted for regular lines, and is already in operation in various

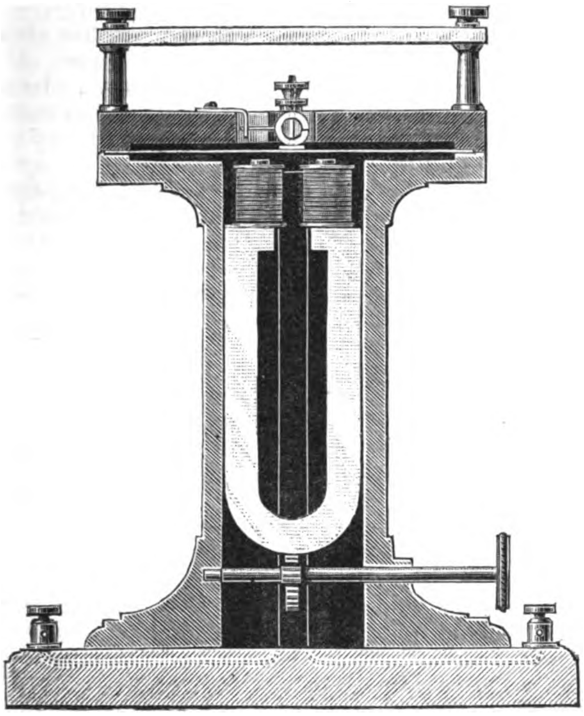

FIG. 2.

places. Several city lines in this city are equipped with it, and the Baltimore and Ohio Telegraph Company and Railroad have it in operation between Baltimore, Harrisburg, and Pittsburgh.

The "phone" local battery only requires three to four cells for the longest distances, say two or three hundred miles. As stated before, the operation of the system is extremely simple, and the condition and length of the line has no effect upon the working.

THE HUMAN BODY AS A CONDUCTOR AND AS AN ELECTROLYTE.*

I HOPE I was able to show in my second lecture the effects of polarisation which occur in all electrolytes, and in the human body to an extent not previously measured, so far as I know. I also showed the important bearing of these physical effects on the physiological observation of electrotonus. But, before I proceed to the subject of to-day's lecture, I have to acknowledge my faults, I have to confess my sins. In the first place, in the skeleton of Mance's method a minus was omitted between the two terms of the numerator and friction, A — B. I will not condescend to say whether that was my fault or not; but it certainly led me to describe the formula as one of multiplication. The product divided by the sum is so familiar a formula to electrical workers that the mistake was natural. But the method really is the difference of two quantities, and very compound quantities, both of them, called A and B, divided by a third compound quantity called C. I understand that the mistake was so very obvious, that I need not occupy more time in explaining how it arose.

Dr. Ord has suggested to me that I did not make the demonstration of the two sounds in the induction discharge quite so clear by the telephone as I ought to have done, and, therefore, I propose to do it in another way to-day, and as it were to carry the practice of oscultation, so well known in this college, a step further. I have arranged a contact breaker, and I will ask you to take the telephones whilst I perform the experiment as I think more satisfactorily. I shall make and break so very slowly that what by habit has become easy to me will be easy to you. Now, the tick is double, but it is distinctly audible, like the tick of a lever watch. That has been made a great physiological point of, but it is reproduced here, without physiological apparatus, without the galvanoscopic frog, entirely by means of the telephone. Here I will end my confessions, and I am now enabled to begin the subject of to-day.

I have to speak to-day of induced currents, and the subject of induced currents has been gone over and over again in every text book *ad nauseam.* I do not wish to repeat all that can be read therein. The current of induction is momentary; it occurs at make and break; it occurs in the second wire; but it can also occur in the same wire, and when occurring in the same wire it is called the extra current. The current on making is weaker than that of breaking, because the extra current in the first wire antagonises the make and assists the break. A sort of momentum is obvious, and this antagonises the action which is going on. Now these induction currents came very early into physiological and therapeutical use. They succeeded, indeed, very soon upon the attempts to produce a frictional current, which date from before the present century, and the reason, I believe, of this is, first of all, from their obvious effect on the sensory nerves; secondly, from their valuable action on muscles as stimulants; and, thirdly—and on this point I need not insist—from the remarkable work done by Duchenne some thirty years ago.

Now, I recollect Duchenne well when I was in the hospitals of Paris about 1856, and there cannot be the least doubt that he, with a very clumsy and primitive induction coil, accomplished, by patient labour, a most marvellous work. He isolated several new nervous diseases. He tested the reaction of muscle to stimulants, and he made quite a new era in our knowledge of electrical stimulus. But the current used by him was not specially or specifically electrical. He had a good muscle stimulant. His coil was merely a convenient way of testing the susceptibility of muscle, and it had no great electrical value. This has done some damage to subsequent electrical work, because it has been taken for granted that the convenient stimulus which he used in the induction coil had some bearing on electricity. In the higher branches I believe it has none. For testing the contractility of muscle it is still unequalled. It is also most valuable as a means of keeping up irritability of muscle which has been damaged by the impregnation of lead, or from which by nerve injury, or more deep-seated lesion, the motor nerve influence has been cut off. But we must recollect that this machine of Duchenne is a muscle stimulant; it is not a nervous stimulant. It is not necessarily an electrical phenomenon at all. No doubt it might be used also, though with more caution, to test sensation. But here individual differences of temperament step in, and the tolerance to induced currents is extremely various in different persons. This has been discounted by the class of people who attend fairs and exhibitions, and who have an enormous machine with a vast amount of bright apparatus on which they ask you, for the remuneration of one penny, to test your strength. All you test in a case like this is

* Concluding lecture by Dr. W. H. Stone, M.R.C.P., delivered at the Royal College of Physicians, April 15th, 1886.

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your particular susceptibility to a certain amount of induced current, and this no doubt varies very much. If the points were taken up scientifically, something might be made out of it; but even this is not really an electrical phenomenon.

No doubt induced currents, may go a stage further, and do good service in stimulating even so deep seated a muscle as the diaphragm in asphyxia or in suspended animation. In cases of opium poisoning I believe the induction current should be used, one pole to be over the nape of the neck and the other pole moving about in front of the abdomen, because it will excite efforts of respiration when hope seems lost. In the lecture room it is a convenient and effective means of physiological demonstration; but there its use ought to end. Even in physiological research it is unsafe, and I very much regret that some recent and valuable researches as to the localisation of brain functions have been founded on the use of induction currents. And, firstly, for this reason, that there is not only no proof that the current passes through the region included between the poles, but there is very conclusive evidence, I believe, that it diffuses itself widely and irregularly in all directions with enormous differences, according to small differences of conductivity. But, secondly, I may even say it is very doubtful if a current passes through a moist substance like the brain tissue at all. I have to show you that it is possible and probable—I believe that is true—that it only starts a series of laminated polarities in a bad conductor, which resembles very much the laminated condition of a condenser. For this reason I spoke of the condenser in my syllabus, and although I had withdrawn the term, I think there is something like a condenser action in this laminated, this polarised state, which the opposite currents from an induction coil may produce in a feeble conductor. However, when I speak of induced currents of that kind I mean the currents obtained from an induction coil.

You can make induction currents by a totally different method from this, and if they are to be used with any certainty they should be used after another fashion—I mean alternating currents obtained by commutating battery currents. Here you are able to measure the electromotive force of the battery.

Now, I had intended to speak of these alternating currents as produced by a tuning fork, but I have found this would pass beyond my limits of time; besides, in the next place, I shall show you presently that it is not necessary further to investigate it, because, as a matter of measurement, it must be thrown aside. But the measure of induction currents is a question of some importance, and of the more importance because, in reading a medical periodical a few months ago, I saw a review which commenced by the general statement that it is impossible to measure induction currents. Now this, strictly speaking, is not true, and I shall proceed next to show you three methods by which induction currents can be measured—first of all by Kohlrausch's dynamometer. But it is too delicate to be shown in a lecture room. It is very good indeed in the silence and quiet of the laboratory. It may be briefly described as a galvanometer in which the moving needle has been replaced by a moving coil. The instrument is in very great use in electrical investigations, but it is hopeless to produce any demonstration with it in a lecture like this. I therefore prefer to take the two simpler and rougher modifications, which answer medical purposes better than that.

I have two here which will answer all medical purposes quite sufficiently, and which are not so difficult to demonstrate. Here is, first, my old dynamometer, which went across the Atlantic with me to the British Association meeting at Montreal; and here is another one, but which, I believe, has not been employed before in this particular way, and in which the whole trouble of having a current through a coil is removed by using a sheet of soft iron. The first I will describe as a coil made of light aluminium wire. Without the electrical contact the aluminium is a substance which for a given bulk is the largest conductor of electricity. By making an aluminium coil you get a light and moving coil, which will act under our small currents. But even that I have since found can be dispensed with. I do not claim to be the discoverer of it; it was discovered in Italy; but I have made with my own hands an instrument, using a coil from another galvanometer. which will demonstrate this very well. If instead of an aluminium coil through which the current is passing, you take two sheets of ordinary or soft iron, they so rapidly change their polarity that they are equivalent to a coil in which a magnetic force is developed. Two soft iron sheets are mounted here between two coils; I shall not waste very much time on this experiment, and I will only just turn the handle of the exploder, which produces a moderate induction current in alternating directions—quite tolerable by the human being—so that this is within the range of what we can stand and use. Now, there I have induced magnetism in these two plates of iron, and I think that will be the dynamometer of the future for medical purposes. It avoids so many complications and difficulties.

But a far better and more accurate determination can be obtained by that most beautiful instrument, the quadrant electrometer. The quadrant electrometer, like the dynamometer, is far too delicate to attempt to demonstrate with in a lecture room, but I have made determinations with it, in which I had the valuable assistance of the professors of Cooper's Hill College, and it is the united work of myself, Mr. Gregory, and Prof. Stocker that I thall reproduce here. I have given two formulæ by which the determination on the electrometer can be made. I do not intend to lay much stress upon it now, but the general principle of it is this—that if the currents are alternating, the needle of the Thomson electrometer must be put in communication with one of the quadrants, preferably with one of the quadrants and then the other. The upper diagram is that given by Prof. Adams in his Cantor lectures, and in the other diagram there is the mode of measurement given me by Prof. Hopkinson. Time will not allow me to dwell upon them; but I will give you a *résumé* of certain determinations made in that way with a fine quadrant electrometer at Cooper's Hill. The process we adopted was to compare the deflection obtained on the electrometer, that is the difference of potential with an alternating current with that of a battery of which we knew the force and which we could measure.

"In these measures," says Mr. Gregory, writing to me, "the negative pole of the battery was to earth, the positive pole being connected at will to either pair of quadrants, and the needle also at will to either pair, giving four readings for each observation. I give only the means which agree very well." The determinations are ·149, ·151, and ·146 each, which gives a mean ·1486. Using the mean value we worked out that the electromotive would give a deflection of 107, which we got. It came out 38. Then we took the same determination with the same electrometer, with the same constant and batteries, and it came out 107·25. "This agrees very well," says Mr. Gregory; so that it will be very easy to value the E.M.F. corresponding to any deflection by the formula which is made here.

We then tried the making and breaking of contacts about ten times a second. The deflection was obviously somewhat lower, so that possibly the effect of rapid alternations is to lessen the deflection for the same electromotive force. But observations seem to point to this, that the mean electromotive force developed by the induction coil is certainly less than 50 volts, and probably nearer 40. I think we may take it at 40. Of course, this is not the maximum E.M.F. Even the electrometer integrates to a certain extent. But still, this measurement, which I think has not been made before, may be taken as sufficient for all our purposes.

We have made a measurement—and a successful measurement—of the force of an induction coil of the ordinary form, and this, instead of being 8 or 10 volts, is at least 40, and may go quite up to 50. Now, I want to show you a curious result that comes from using

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this induced current of from 40 to 50 volts passing in an alternating current through the human body; and here again I shall have recourse to my telephones, for I have discarded the galvanometer for the more sensitive and delicate telephone. I shall introduce the human body into the circuit, and I shall use for this purpose Kohlrausch's combined induction coil and meter bridge with the telephones. Here the electromotive force which is working it is only four volts—two bichromate batteries—and I will ask you to put a telephone to your ears. I have a quarter of a metre here of fine platinum silver wire, and a number of fixed resistances, so I will employ a hundred resistances, and then I will employ a thousand, but I am afraid my human patient will not stand it, and when I get balanced you will find that the telephone will cease to speak.

I get 600 ohms against 1,100 given by the constant current. Now, this is very important. The same man whom we tested at the first lecture only shows 600 ohms resistance, whereas to the constant current he shows 1,100, and this is invariably the case, and I believe the observation is absolutely new. Of course, however, the first result of it is that it is clear that this induction current cannot be used for the measurement of human resistance. We lose something there. But, on the other hand, we get physiological facts of very considerable importance, and the explanation of this difference is what I will next proceed to consider. It is susceptible of several explanations. In the first place, the human body, like all imperfect conductors, in all probability is more permeable to high tension than to low tension currents. This occurs in all feeble conductors. I think the effects of these experiments alone fairly prove this, and there are many that you come across in telegraphic work which prove it. Indeed, the diagram we had last time, when we used an E.M.F. of two volts, four volts, six volts, and eight volts, showed a distinct falling of resistance as the E.M.F. was increased. But there is a great deal more than this. It is probable, as I said before, with the rapid intermission, the current does not pass at all, or not fully, until it is met and annulled by the next current in the opposite direction. Thus the body would be like the leaves of a book in a stratified or laminated condition, or more closely like an elastic body transmitting the waves of sound with alternate plates of condensation and rarefaction represented in this case by positive and negative polarities. Now, curiously enough, this comes out from Du Moncel's early and successful experiments. He found that there was inside the charged body something like the leaves of a book. There was the new polarised current obtained at the extremities, and at first giving an opposition current, which soon yielded to the old current which had been established internally. This seems to me to be a proof that the body can take up a series of laminated polarities, and does not transmit these induced currents.

But there is a third reason which, I think, ought to be considered, and that is, as Dr. Oliver Lodge has suggested to me, that an alternating current ought to show too low a resistance because of the electrochemical capacity of the body which the current would treat as conductivity—the reciprocal of resistance. If we were to measure the resistance of a perfect condenser with alternating currents it would not come out infinite even if the insulation were as perfect as it could be made. Here, again, was the reason for my putting into the syllabus that there was something like a condenser action in the human body. Lastly comes the fourth point, and, as I believe, there is considerable self-induction. Now, self-induction is a word which involves a great deal of difficulty. It is to be avoided in all induction coils, and in all resistance coils. The possibility of its playing a considerable part in the actions now before us was brought strongly before me only two months ago by a highly suggestive paper by Professor Hughes read before the Society of Telegraph-Engineers on January 28th of the present year. He gives a very good account, and a very perfect account of what is known of self-induction. Induced or secondary currents in a double circuit were discovered by Faraday in 1831. The phenomenon of self-induction, or an electric current on its own wire, was observed by Henry in 1832, and enlarged upon by Faraday in 1834. He proved that by sending a current through a wire a momentarily induced current in the opposite direction is evoked in its own wire, and also on the cessation of the primary current excitement is induced on the secondary.

I will not go further into that now. What I have to note here is that Professor Hughes makes two different periods—the stable period and the variable period. The ordinary current from the battery is not in itself used—is not tested—until it has got to the stable period, but the induction current is in the variable period. There is some controversy as to the mathematical interpretation of these facts; but my own belief is that in the main they point to a new direction of research which may be utilised by physiologists. He divides the current into stable and variable periods. The continuous current is stable, and the interrupted variable, so that it is in the latter that induction takes place. Professor Hughes has brought his improved method of investigation forward in place of the time-honoured Neef's hammer, as in Du Reymond's coil. He uses his own invention, the microphone, or, still better, a small contact-breaking clock. This enables the ordinary meter bridge to be used for measuring resistance, and if time allowed me I would show how it works. But you may combine this mode of measurement with Professor Hughes's sonometer. I have here a simple form of the sonometer, in which the induced coil slides along a bar. As I slide this along the bar I think you will be able to detect the effects of induction.

I am very glad to have been able to show what I believe is a perfectly new experiment, and I will admit that it is somewhat difficult to show. If these coils be set up at measured distances, and an interrupted current passed through the primary coil, the patient, and a known resistance in the secondary circuit on either side of the telephone, good measurements can be obtained. There is a still further modification of the instrument that I do not propose to go into to-day. This is Professor Hughes's last discovery. He blends together a Wheatstone bridge and a sonometer, by which I hope we shall be able to balance, if it will act, not only resistance but self-induction. I have not been able to make any definite measurements yet. The instrument has only been before the public since January, and this particular instrument, which takes some time to make, has been in my hands only for a fortnight or three weeks, but I think, if I cannot give exactly the measurements, I can give demonstrations which will enable you to see what it means.

But whilst this is being put up I will occupy your time by a few general considerations. I think I have been able to show you that here is a great field for future research—that the whole basis of physiological electricity requires strengthening and re-examining. It is a stately building built by Du Bois-Reymond and many others, of which the foundations are unsafe. Until these are made firm the whole superstructure is in danger. But if, on the other hand, we set to work and strengthen the foundation we shall in the course of the necessary explorations come on many precious discoveries. Already the analogies between the nerve force and this great physical force—electricity—are becoming very strong, and one such, on inhibition, was published in *Nature* by Dr. Lander Brunton. He took up the theory (I hope it may be true) that different lengths of nerve conductors might transmit wave influences at a period such that there should be interference, and so inhibition might occur; and I ventured at the end of my syllabus to place another such attempt to go out into the infinite unknown, by saying that there are many analogies between the condition of the human body and a duplexed Atlantic submarine cable.

The curious thing about the submarine cable is that

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its results are produced at the far end, and that nothing is shown at the near end. How like this are many nervous actions of the human body! When you see these strong analogies you cannot resist the impression that nature must have worked upon one plan, and although we have not found it there must be some link between the two. I do not wish to lay any stress on the duplexed cable other than that it produces on my mind, and it may on yours, a strong feeling that the analogy is too great not to be in a certain sense real, although not yet discovered. And we are coming upon this every day. It is a most desirable thing that we should come upon this, because every connection that can be found between physical facts and that unknown vital region which we have been accustomed to investigate is one step further on the road to truth, one of the mysteries taken out of the unknown and added to the known.

I shall conclude by offering a few observations as to what are the hopeful directions of electrical work. I see the therapeutical use of electricity looming before us in the direction of muscular enfeeblement, palsy, and what has been called reflex action. I am not quite certain of its value on the sensory nerves in cases of neuralgia. I mentioned and gave you the details of a case of sciatica, which I have no hesitation in saying was instantly and momentarily cured by a continuous current. I believe it is of great value in neurotic cases, such as locomotor ataxy. It has the power of loosening chemical compounds in the body. Therefore, it follows that it should be an eliminative, and that I am absolutely sure it is, because I have extracted from a fellow creature by electrical action 3 milligrammes of copper. The same thing has been done often and often with mercury.

I think that concludes what I have to say on the subject of electricity. But beyond that I have something to say. I have to thank you all. I have had the intelligent support of my colleagues. I have been honoured by the presence of my brother censors, and I have received the greatest kindness from all connected with the college. I have had the patronage besides of men not belonging to the medical profession, like Sir Henry Mance—an honour which I cannot too highly appreciate—and I have enjoyed the careful attention of many of my students. I thank you all sincerely, and I will finish by a well-known formula, thus reviving a time honoured practice of this learned body:—

Dixi quod felix faustumque sit hinc collegio.
Vos omnes volete et plaudite.

ABSOLUTE SPHERICAL ELECTROMETER.

By M. LIPPMANN.

THIS instrument is essentially composed of an insulated metallic sphere which is brought to the potential, V, sought to be known. This sphere is divided into two hemispheres movable in relation to each other, and which repel each other with a force equal to f when their system is electrified.

We have between V and f the simple ratio easily demonstrated

$$f = \tfrac{1}{8}\,V^2.$$

To find V it is therefore sufficient to measure f. This measurement may be effected by various procedures, of which I prefer the following :—

At first, if the apparatus intended to measure f was outside the metallic sphere, we should be obliged to place it at such a distance that it should not exert any appreciable disturbing action on the electric distribution. I prefer, therefore, to place it entirely in the interior of the electrified sphere, which is hollow.

One of the hemispheres is fixed; the other, movable, is suspended by a trifilar system, that is to say, one composed of three vertical wires of equal length. When the repulsion is produced the movable hemisphere can only be displaced parallel to itself, the three suspending wires forming then a small angle, α, with their original vertical position. We measure α by the method of reflection by means of a small mirror cemented to two of the wires and visible through a small aperture. If we call p the weight of the movable hemisphere we have

$$j = p \tan. \alpha$$

and consequently

$$p \tan. \alpha = \tfrac{1}{8}\,V^2.$$

It is therefore sufficient to know the weight, p, which is invariable; as for the radius of the sphere, its value is evidently indifferent.

In a second specimen of the same instrument which I have the honour of submitting to the Academy, the system of the two hemispheres is contained within a concentric spherical envelope of copper which is placed in communication with the earth. This arrangement increases the sensibility of the instrument and secures it against currents of air and external electric perturbations.

If we call a and b the radii of the two concentric spheres we have

$$= \tfrac{1}{8}\,\frac{b^2}{(b-a)^2}\,V^2.$$

Here a = 3·9 cm.; b = 4·92 cm.; p = 3·322 grammes.

It follows that if we place a scale divided into millimetres at 1 metre we have as the value of the deviation

$$d = 0{\cdot}00373\ V^2.$$

If we express V in volts we have

$$d = 0{\cdot}0000140\ V^2.$$

It is advantageous to multiply the sensibility of the instrument optically by reading off the deviations by means of the eye-piece of a microscope magnifying from 15 to 50 times, as was recently proposed by M. d'Arsonval. We thus diminish in the same ratio the deformation—which, moreover, is very small—which the system of the two hemispheres undergoes in consequence of the deviation.—*Comptes Rendus.*

DECOMPOSITION OF WATER BY MEANS OF A DYNAMO MACHINE ROTATED BY HAND.

By J. W. GILTAY.

SOME time ago the following phenomenon was communicated to me: An attempt had been made to electrolyse water by means of a small hand dynamo machine, but although the machine was rotated as rapidly as possible, there was no evolution of gases observable. Accidental communication was established between the terminals by which the leads were connected to the platinum electrodes, and the decomposition of the water followed at once; when the terminals were shunted by a metal wire of a resistance of a few ohms, the liquid was likewise electrolysed.

In the subjoined diagram a represents the gramme ring, and b the field-magnet of a small hand dynamo; a and b are wound in series with thick wire, and the pole terminals, p and q, are connected to a voltameter. As soon as we now begin to rotate the armature, it moves in a feeble magnetic-field which owes its existence to the weak residual magnetism of the field-magnet. So long as the difference of potential between the terminals, p and q, remains less than 1·4 volt, no current will pass through the voltameter, that is to say, if we leave the very feeble convection currents out of the account, it follows that no current will circulate in the coils of the field-magnet; the number of the lines of force remains consequently constant. If we cause the ring to revolve more

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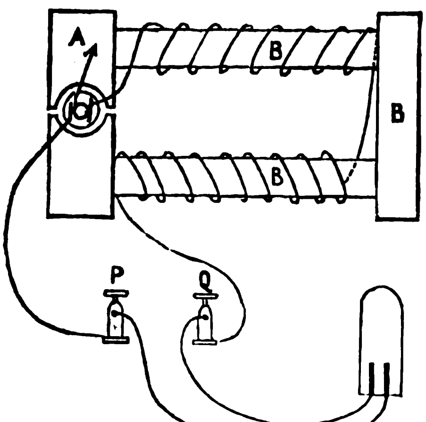
rapidly, the number of lines of force cut across by the coils of the ring in the space of a second will be proportional to the velocity of the rotation. If we could rotate the machine by hand with a sufficient velocity, the difference of potential between p and q would soon reach 1·4 volt, and the liquid contained in the voltameter would be decomposed. It was, however, not possible to attain such a velocity with the machine with which the experiments were made. But the case



is different if we connect the terminals, p and q, by a metal wire as well as by the voltameter. As soon as we cause the armature to rotate, a certain difference of potential is set up between p and q, in consequence of which a current passes through the wire, p, q, and further through the whole circuit. The strength of the field is thereby increased, consequently the currents induced in the coils of the ring acquire greater intensity. The difference of potential between p and q will now rise more rapidly by an increased velocity of rotation than in the former case, because the number of lines of force in the magnetic-field increases. In a short time the difference of potential between p and q will amount to 1·4 volt, and the current will divide itself into two branches: one part will pass through the voltameter, and the other part through the shunt wire; the current strengths in both branches of the circuit are inversely proportional to the resistances; and electrolysis of the water will consequently take place.

The cause of this phenomenon is obvious enough, and I would not have mentioned it if it had not induced me to make another experiment, which, as far as I know, is novel, and which shows very clearly that an iron core requires a certain space of time to lose its magnetism. I proceeded as follows:

The terminals, p and q, were connected by a copper wire of very low resistance. However rapidly the armature was rotated, not the least decomposition of the water was observable. Probably the difference of potential between the points, p and q, which were connected by a conductor of very low resistance, was less than 1·4 volt; it is, however, possible that the difference of potential reached, or even exceeded, 1·4 volt, but if that was the case, only an extremely small quantity of electricity would pass through the voltameter in consequence of the high resistance of that branch of the circuit, and the fact that as good as no evolution of gases at all occurred is therefore easily explained. The Gramme ring, in this case, moved across a very powerful magnetic field, as was evident from the great amount of energy required to work the machine.

I inferred now that the field-magnet would not lose its magnetism suddenly on the interruption of the shunt connection between p and q. If my inference was correct, the armature would after the disconnection of the shunt still move for a moment across a powerful magnetic-field. The difference of potential between p and q, now separated from one another by the great resistance of the liquid, would then possibly amount to 1·4 volt or more, and the decomposition of the water would set in; and as then, in that case, a current would circulate in the voltameter and, consequently, also in the coils of the field-magnet, the field of b would retain a certain intensity, and perhaps it would be possible to observe in this way, with a sufficient rapidity of rotation, the continued electrolysis of the water.

This experiment completely confirmed my theory. Whilst p and q were joined by the short shunt, there was no evolution of gases observable even with the greatest possible rapidity of rotation; but when I disconnected the shunt whilst the armature was being rotated, the evolution of gases set in at once and continued as long as the rotation was maintained. When I stopped the machine for a moment and then set it in motion again, no decomposition of water would take place unless I had first shunted p and q for an instant.

When two voltameters joined in series were connected to the terminals, p and q, gases were evolved in both after the disconnection of the shunt. This evolution of gases diminished, however, rapidly, and ceased altogether after the lapse of about one second. By this experiment I could, as it were, *see* the field-magnet gradually lose its magnetism.

As soon as the decomposition of the water ceased, it was evident from the greater ease with which the armature was rotated, that considerably less energy was required to perform that operation.

SELF-INDUCTION.

THE discussion and controversy which has been occasioned by Prof. Hughes's interesting paper on self-induction, not only shows the importance of the subject as well as the interest it has excited amongst electricians in Europe and America, but it also brings to light the manifold ways in which it is criticised, commented upon, and even discredited.

In asking you for space in your valuable journal for the following lines, my object is not to enter into a discussion with Prof. Hughes's critics, but to offer a few remarks on the physical aspect of the subject of self-induction, in explanation of the various phenomena presented to us in the experiments and their results; because I feel convinced that such phenomena are better explained when submitted to physical in contradistinction to mathematical reasoning, and I am prepared to be called "ignorant" by mathematicians when I confess that I cannot comprehend how mathematics, the science of magnitudes, can be employed to prove physical facts—to prove the cause of water being lifted by a suction pump, or the cause and nature of electric or magnetic induction. Mathematics can determine *the relations of* magnitudes, either in numbers or in space; with its aid we can interpret the results of experiments, but we cannot by means of it prove the cause and nature of physical phenomena; and I consider it is to the discredit of mathematicians when they (or Mr. Oliver Heaviside) ask us to believe that their formulæ contain an explanation of the results of Prof. Hughes's experiments. Prof. Ayrton very properly remarked that: "the increased resistance that Prof. Hughes has shown us to exist in a wire through which an intermittent current is flowing . . . . . could be anticipated from the ordinary mathematical calculations . . . . . if *one had a complete knowledge of nature*." Quite so! Experiment should go hand in hand with logical reasoning and the employment of mathematics; but the latter science can only serve to complete and to qualify the former.

Among the many unexpected results obtained by Prof. Hughes, there is one which I think deserves more than ordinary attention; it is the fact that the self-induction in an iron wire is considerably reduced when the wire is coated with copper. I do not think it has been referred to either in the discussion or in the subsequent correspondence; yet it seems to me to

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assist greatly in explaining the very result which is questioned by Prof. Weber, and, further, in enabling us to get a better insight into the nature of self-induction. So far as I remember, the only speakers in the discussion who looked upon self-induction as a purely physical phenomenon were Profs. Forbes, Thompson, and Ayrton. Prof. Forbes, with a certain emphasis, declared that the electromotive force (of the induced current) was strongest in the centre of the wire; hence here would be the strongest induced current; and by inference we must conclude that Prof. Forbes considered the primary current to flow through the conductor nearer the circumference, since both primary and induced current could not possibly exist in the same portion of the wire simultaneously. For it is not easy to conceive that the primary current when starting in the central portion of a circular conductor should *there* create an E.M.F. (Prof. Forbes does not say in which direction) in the same direction as the primary current, and so cause an induced current contrary in direction to the primary. Prof. Thompson declared that he was "perfectly aware that in the case of a solid circular conductor the current, when first turned on, and when it is rising in strength, rises in the outside before the inside," and he thinks this is evident, since "that is accounted for by the counter-electromotive force of self-induction in the interior of the solid conductor." But, I ask, where is the proof that the E.M.F. which produces the induced current is strongest in the centre? Prof. Thompson adds: "I cannot but think that the proof Prof. Forbes describes has got some little fallacy lurking at the bottom of it."

Prof. Ayrton (with Prof. Thompson) could not agree with the view stated by Prof. Forbes, &c., &c.

I here beg to offer a physical theory of the nature of self-induction (or induction generally), and beg the reader to accept the remarks for what they are worth.

In a uniform magnetic field we can assume parallel lines of magnetic force, and at right angles parallel lines of electric flow, as roughly illustrated in fig. 1, in

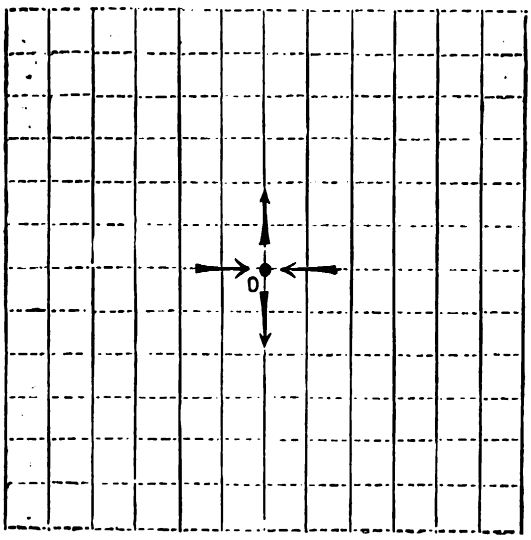

FIG. 1.

which the dotted lines represent the magnetic, and the solid lines the electric lines of force. Taking any point, *o*, in that field we have, in the direction of the magnetic lines of force *attraction*, and in the direction of the electric lines of flow *repulsion*, as verified by well-known experiments. And since no lateral attraction exists between conductors until a current flows through them, we can assume that the attraction takes place also between the lines of electric flow *in one and the same conductor*. From this we should be justified in assuming still further, that when a current is sent through a conductor, let us say of circular section, it, the current, will flow through the central part or axis of such conductor, but, heating this portion of the wire and so increasing its resistance, will spread towards the circumference, still always with the tendency of concentration towards the centre.

From the fact that an electric current of sufficient strength will cause disrupture of a conductor, we can assume that even a comparatively weak current causes a strain in the conductor in proportion to the strength of such current. Let us make an attempt to illustrate this by representing the longitudinal section through the centre of a wire, as shown in fig. 2, in which a current is started from *a* to *b*. Its effect would be to separate the atoms situate along the central line; but through their cohesion amongst themselves and the adjacent atoms this effect would impart itself to these latter, and in this way spread towards the circumference, C, C, of the conductor. And further: this

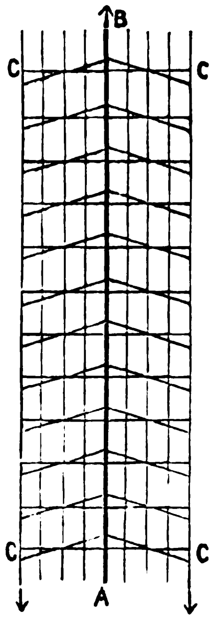

FIG. 2.

disturbance in the cohesive force along the central line of the conductor in the direction from *a* to *b* would cause a similar disturbance amongst the atoms along the circumference of the conductor in *the contrary direction*, until the balance of the forces, acting between the atoms under this continued strain, had been re-established, or until the strain caused by the primary current had diffused itself across the whole section of the conductor. This accommodation or adaptation of the atoms of the conductor, which takes place when a current is started, and which requires a certain time to be accomplished, would in itself explain the retardation in the establishment of the full primary current; and the reaction of the central portion of the conductor upon the circumferential parts (or upon a separate conductor adjacent to this primary current) would explain the formation of the induced current. We can in a similar manner conceive how the extra current is produced when the primary current in the conductor ceases and so causes the normal cohesive balance between the atoms to be restored. It may be retorted here that I assume cohesive force between the atoms as equivalent to electric force. Well, I take my standpoint on this, since I think that the production of electricity by friction or compression, as well as by chemical action, rests on the act of setting free or disturbing atomic or molecular cohesion; hence the universal and indestructible nature of electricity.

The question here arises, to what an extent does this central disturbance in a conductor spread laterally towards the circumference or surface of the conductor when considering wires of different diameters to be subjected to our experiment (of *starting* an electric current). It would naturally suggest itself first that the magnetic character of the metal, but secondly also the nature of the metal with regard to ductibility,

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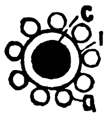
elasticity, &c., must have some influence upon it; but, I think, so also must the current density; that is, the proportion existing between the strength of the current and the section of the conductor. With the same strength of current, let us gradually increase the diameter of the wire experimented upon. We can conceive that, with an increased section, the number of atoms which have to be acted on in starting a current in the conductor also increases, and that the retardation of the main current in starting becomes greater in proportion to the greater number of atoms agitated. Yet it must be remembered, also, that this lateral action would exhaust itself by reason of the elasticity in the atomic structure of the metal. Hence, when increasing the diameter of the wire, with a constant current, we, no doubt, increase the retardation in starting a current; but this should cease sooner or later, with increased diameter, according to the nature of the metal; and beyond this, *i.e.*, with further increase of diameter we should have a stronger induced current in the outer ring of the conductor, which, by *its reaction*, would assist rather than retard the main current. Prof. Hughes's table, as given on page 12 of the *Journal of the Society of Telegraph Engineers and Electricians*, comes in here to support me, although Professor H. F. Weber (see ELECTRICAL REVIEW, No. ccccxxvii., of April 9th, page 321, second column, line 20 from below) thinks these tabulated results "*contradict*" THE VIEWS "*hitherto in vogue in electrodynamics*." Quite so! since these views are based simply on the influence which magnetisation of a conductor has upon self-induction, and since, in their mathematical calculations of the co-efficient, the diameter alone is brought in as a factor, and not the nature of the metal as referred to above. Prof. Weber forgets that, between two separate conductors, we grant to the intervening substance, such as air or india-rubber, a special inductive capacity; why should we not also do the same when the question arises of an induction in the same conductor which carries the main current, leaving magnetisable metals out of the question.

The facility with which the induced current can establish itself will, no doubt, also react on the main current. Let us return to our iron wire, which we consider of comparatively a large section. When a current is started, circular lines of magnetic force will be established round the axis, causing an induced current through the conductor in the contrary direction *near its surface.* The larger the diameter the greater the number of atoms acted on, at the same time the larger the section of conductor for the formation of the induced current. Now, let us place a coating of copper round this iron wire, and the result will be that, although we have increased the number of atoms through which the induction takes place, we have supplied a conductor of considerably less resistance. The result is a stronger induced current which, reacting on the magnetic iron wire, assists the primary current, and so apparently lessens the retardation in the formation of the full primary current.

Applying this theory practically, we should obtain the best result, *i.e.*, apparently least self-induction, by taking a copper wire as a main conductor, encircling this with iron wire (in the manner in which pianoforte wire is covered), and placing outside this iron covering a ring of copper in separate wires or strips.



C.—*Copper conductor.*
I.—*Iron wire twisted round inside conductor.*
O.—*Outside copper wires or flat strips for developing induced currents.*

From the above theory we might draw the inference that there is a limit at which an increased section of a conductor will reduce its resistance in proportion to such increase.

With regard to the experiments to prove the existence of self-induction and to determine its magnitude, I shall have to say a few words on Prof. Hughes's apparatus; but I know that he is large-minded enough as a worker in scientific research to pardon my presumption in making some suggestions as to the form of apparatus and the nature of the experiments. With your permission, I shall make this the subject of my next communication.

C. GODFREY GÜMPEL.

Burstow, Surrey.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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(*Continued from page* 397.)

SCIENTIFIC men, at the time of which I am speaking, were much engrossed with my doings, and considerable speculation was doubtless excited in their minds as to finding ways and means for my further development. It naturally occurred to some to duplicate the various members of my frame, and to fashion me after the manner of the Siamese twins. Others still further multiplied my parts, and of course correspondingly increased effects were forthcoming from the source of my extraordinary powers which was ever in a perfect whirl, a whirl, too, of constant excitement, a state in which I suppose I shall end my days.

Indeed, it is absolutely essential for my vitality that I should be subjected to this continuous round of excitement, for otherwise I become perfectly inanimate. It was not until the year 1849 that a decided opening was given to me for industrial purposes, an opportunity for which I had long been patiently waiting. M. Nollet, a professor of physics in the Brussels Military School, constructed in that year a large machine based upon the form given to me by Mr. Clarke. You can readily conceive within your own mind how the task of transforming me into a multiple apparatus could be carried out, and I then presented an appearance which can be described in a few words.

My framework was of cast iron, carrying 40 steel magnets of the horse-shoe form. These were symmetrically and radially arranged in eight rows of five each with their poles turned towards the centre. In the spaces between the magnets and attached to a horizontal axis there revolved four brass discs each carrying 16 single electro-magnets or bobbins similar to those which I showed you but a few minutes since when trying to explain to you the action of the commutator. You will understand, therefore, that there were in all 64 of these bobbins, and that during one revolution of the discs carrying these, each bobbin had its magnetic polarity reversed 16 times. There were then no fewer than 1,024 electric impulses or currents of the alternating kind developed within me in a single revolution, and if you will imagine me being driven at say 200 turns per minute and in operation for producing the electric light for which purpose I was afterwards set, a simple calculation will show that the number of my alternations per minute amounted to 204,800. I was overhauled and modified here and there by Prof. Holmes, the Count du Moncel, a man who has done much towards the popularisation of electrical science in all its branches, and others, and although still producing alternating currents only, I had now become of much importance in the world, and for the first time I was thought of sufficient value to be energetically taken in hand with the view of turning my wonderful capabilities to account. This led to the formation of a company called "The *Alliance*," with which I was allied, but as I was called upon to effect objects for which I was not yet quite suited, and which, indeed, were visionary and illusory in themselves, the company, and with it my alliance came, as might have been expected, to an untimely end. So ended my first experience in a commercial sphere.

Thanks to the perseverance and skill displayed by

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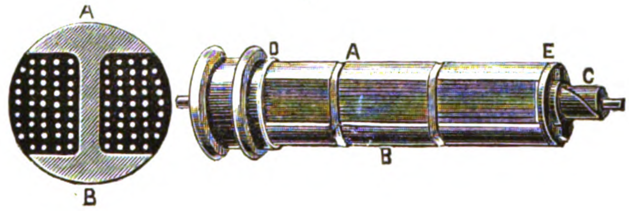
Prof. Holmes who would not acknowledge me to be a failure in any way and notwithstanding my unfortunate connection with the *Alliance* Company, I was finally and in a still more improved form, installed in the Dungeness Lighthouse in the month of June, 1862, from whence, through the medium of an electric lamp, I shed at night upon the anxious mariner a light which, to quote the illustrious Faraday, was "so intense, so abundant, so concentrated and focal, so free from undershadows and from flickering, that one cannot but desire it should succeed." To what extent this wish of the great philosopher has been brought about you can see for yourself in these days of what is still the "light of the future."

In 1856 was patented by Dr. Werner Siemens, of Berlin, an improvement in the method of producing electric currents which may be termed the most important innovation since the days of Pixii. Previous to this the electro-magnets, or revolving coils of magneto-electric machines, did not turn in a very *intense* magnetic field, and the invention which I now bring before your notice was, although most simple in itself, of great practical value.

It consisted of a soft iron rod or cylinder, A, B, of a length regulated by requirements. A deep groove was cut in the ends and along each side of the cylinder, and in this groove was coiled a long length of insulated copper wire. To its two ends were secured the brass discs, E and D respectively. With E was connected a commutator, C, of simple construction, consisting of two pieces of metal insulated from each other as here shown, and connected respectively with the two ends of the wire.

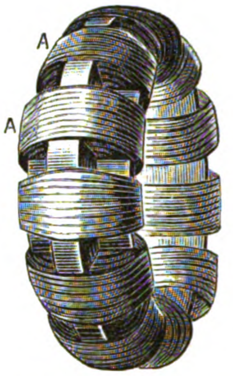


A Siemens Armature with Enlarged Section.

On the other disc is a pulley by means of which the complete cylinder, known technically as the *Siemens armature*, can be rapidly rotated between the poles of a magnet or electro-magnet. When this is done the sides, A, B, become alternately magnetised and demagnetised, and a series of alternating *positive* and *negative* currents are thereby produced as in Clarke's form of machine. The principal advantage which this armature of Dr. Siemens possessed lay in the fact that owing to its peculiar construction it could be placed between the poles of magnets which were brought very close together, the magnetism acting upon the revolving copper wire, or the "magnetic field" through which the coils rapidly passed, being thereby rendered more intense.

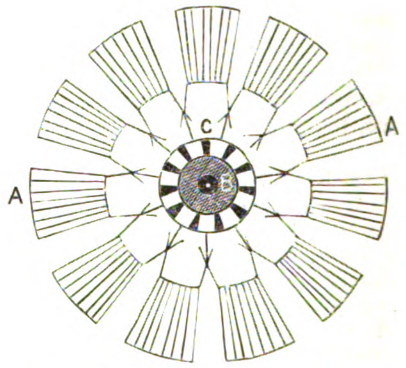
I had frequently asked myself how long I should remain in this "alternative" form, for I was firmly convinced that sooner or later the man would be found who would so remodel me as to enable me to produce *continuous* currents without the aid of a commutator to redirect my alternations.

Such an inventive genius was personified in Dr. Pacinotti, of Florence, who, in the year 1860, constructed a machine which is virtually the prototype of nearly all the dynamos existing at the present day, the leading examples of which you see before you in this very building. The Pacinotti armature was a complete departure from anything which had preceded it, if we except the ring armature of the electro-motor devised by Elias, of Amsterdam. This, however, was not I think ever intended to act as a dynamo proper, or generator of electric currents, so it suffices merely to make mention thereof. Yes, an electro-motor is really the reverse of a dynamo; the latter is driven mechanically and produces a current which can be utilised for a variety of purposes, the electro-motor is *supplied* with an electric current from an independent source, and it is then available for performing mechanical work. Understand me, however, that the dynamo proper is convertible, *i.e.*, a good dynamo will also act as a good electro-motor, but this was only practically found to be the case at a more recent period than that of which I am now speaking. To return to the Pacinotti armature: this consisted of a ring of iron around the circumference of which were 16



A Pacinotti Ring or Armature.

teeth or projections of equal size and at the same distance apart. The notches or spaces between these teeth were filled up by coiling them with insulated copper wire, these coils being firmly held in their places by



Method of Connecting up Coils.

wooden wedges, which I do not think it necessary to include in the sketch I now make of Dr. Pacinotti's invention. I will, for the sake of illustration, show you the position of the coils, *a*, *a*, for, as I have just observed, all the spaces were fitted in like manner. The coils were all wound in the same direction, and the terminating end of each coil was fastened to the commencing end of the next and so on round the entire ring. This you can more readily understand by this diagram in which I show you a few coils only, leaving the ring upon which they are wound out of the question for the moment.

You will notice that this winding forms a *closed circuit* of insulated copper wire with a certain number of points where the end of one coil is soldered or screwed to the end of another. These junctions were attached to just as many slabs of metal or contact pieces arranged round the surface of an insulating cylinder of boxwood, but the contact pieces were kept carefully apart from each other, so as not to be in metallic connection *across* the boxwood cylinder. The only communication, therefore, between slab and slab was by means of the coils of wires to the ends of which they were attached as you see in the figure. Here *a*, *a*, are the coils, *b* the boxwood cylinder placed upon the axis on which the ring revolves, and *c*, *c*, are the contact slabs, to each of which the beginning of one coil and the end of its neighbour are attached. I have, in this

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illustration, shown you only 11 coils, but in my original form, as moulded by Pacinotti, I was burdened with 16. How the current was developed within my ring and the manner in which it was collected for "external application only" I will now explain to you.

(*To be continued.*)

ON THE THAMES IN AN ELECTRIC LAUNCH.

SCUDDING along on the bosom of Father Thames, without sign of oar or sail or steam boiler! Truly it was a delight and a wonder—a delight to us who were favoured with a seat in the boat, and a wonder to the craft we passed and to the spectators who soon gathered on pier and bridge and embankment. No visible motive power, and yet we shot through the water at a rate which quite out-distanced the bull-dog tugs, and even caused consternation and surprise on the bridges of the larger steamers carrying passengers.

Surely here was a second Captain Nemo with his electrical boat, which moved or was still, answered the helm with or against the tide with equal ease, and perhaps—who knows—even descended into the water, at the will of the owner! She did not explore the depths on Saturday, though, and no one was sorry, for she did not seem altogether fitted for submarine travel. One attempt, indeed, she made, but nobody appeared to like it, so to the surface again she returned. Perhaps the gentleman in command thought he would give us a taste of what the boat could do if necessity arose, but had pity on us when he recollected that no provision had been made for going to the bottom of the Thames. Or perhaps it was only that she shipped a sea in the rough water in the Pool, and our excited imaginations immediately suggested that we were to be submerged. At any rate, we got wet, and let it be distinctly understood that we preferred to remain, for the present at least, fair and square on the top of the water.

We met on Charing Cross Pier: quite a number of electrical celebrities arrived a little later; and presently, up the river came Mr. Reckenzaun's wonderful little launch, with two or three ladies on board, Mr. Reckenzaun himself, Mr. Stephens, and the assistants required for the management of the boat. Simultaneously with their arrival, there came on to the pier a turbaned Hindoo (I am not sure that he was a Hindoo, but he *was* turbaned and was of Oriental appearance, so that's sufficient), who, with astonishing temerity, walked straight to the edge, and, without hesitation or apparent misgiving of any kind, descended into the launch as though he had known it all his lifetime and it had come now particularly for him. The others, not quite so stolid, stayed to remark on the boat's appearance and calculate its capacity, to greet its occupants, and to assist the ladies to *terra firma*. (Is that pier "*terra firma*," by the way?) It was clear there was not room on board for all who were prepared to commit themselves to the mercy of the waves —(there *were* waves)—so something like thirty souls went off first for a short cruise, and as many, or more, waited. "The anchor's weighed!" roared Mr. Stephens, and the boat was steered away in the direction of Westminster; without passing under the bridge, it crossed the river, came back on the other side, and recrossed.

I do not think anything very exciting occurred on the first trip; nor, indeed, on the second. But subsequently we had quite an adventure. "Boat ahoy!" shouted a "jolly young waterman," making straight for our boat. (I did not hear him say "Boat ahoy!" but that is the proper thing to say, and no doubt he said it.) Visions of pirates, of highwaymen on the river, for a moment made me wish myself safe on the Embankment; but I was soon reassured when I saw that the j.y.w. could not keep pace with our little clipper, and heard him call for nothing more dreadful than "Your license!" The youth at the rudder was addressed, but for all notice he took of the demand he might have been as great a stranger to the language of the waterman as he probably was to that of the turbaned Hindoo. Our boat did not stop, and the other began to fall behind, although "young Tom Tug" made desperate efforts to keep alongside, all the while shouting for the license and commanding us to stop. All his skill, however, was futile, and presently he desisted from the attempt to overtake us, and contented himself with yelling that he would make us "Pay for this," and shaking his fist at us. On the return journey, when he saw us coming, he again made for the middle of the river, but he hadn't time to get within hailing distance before we passed the point for which he was making. I had observed this young man rowing about the river previously, and eyeing very closely the mysterious little boat, which he did not seem quite able to make out. Evidently he came to the conclusion that it was illegally plying for hire, and he resolved to put a period upon its operations. He must have been chagrined by the way in which the occupants of the demon boat ignored him and his importance.

Mr. Stephens entertained us with a description of the main points of the launch; and a man readier with anecdote *apropos* I never encountered. "How thick are the plates?" enquired a passenger. "One-sixteenth," replied Mr. Stephens. "Only one-sixteenth!" "Ah, you are like the man who built a boat with plates three-sixteenths of an inch in thickness, and would not trust himself in it upon the water because there would be but three-sixteenths of an inch between him and eternity!"

Many more lively little stories like this kept us all in good humour; and Mr. Stephens had a happy way, too, of giving us the information we desired to possess respecting the boat. "She has a very peculiar bottom," he told us; "and, upon my word, I believe she would turn on her own centre." With a length of 37 feet and 6 feet breadth of beam, the launch was fully capable of carrying comfortably 40 persons. Seats ran around the sides, and the passengers faced each other. She was built some time ago by Yarrow & Co., the famous torpedo boat builders, and is intended for the service of the Italian Government, who will use her for general harbour purposes, laying torpedoes, and other work for which she is peculiarly adapted. The arrangement of the motors, the secondary batteries, and the switches, which are all out of sight, is precisely the same as that in vogue on the tramcar system devised by Mr. Reckenzaun, and which the ELECTRICAL REVIEW has fully described.

We had ample evidence of her powers of speed, for she was put through her paces for our benefit on a straightaway run from Westminster Pier to Charing Cross Pier. Mr. Gisbert Kapp timed her as doing just two minutes. This distance, according to the map, is about 730 yards, and a rough calculation since worked shows that the speed attained was at the rate of close upon 12½ miles an hour. Somewhat faster than that accomplished by the *Great Eastern*, which found it difficult in its journey to Liverpool to get above 5½ miles an hour. Of course, we had the tide in our favour. When upon her trial on the measured distances at Greenhithe, the boat showed an average speed of 9½ miles an hour with the tide, and of 7½ miles against it. These, however, were at the ordinary working speeds, and when we timed her she was under what may figuratively be termed "high pressure." Fifty miles, on another occasion, she accomplished in six hours: very satisfactory work.

Well, the boat behaved capitally on Saturday, and the three-score or so of interested visitors were highly pleased with her performances. Those who left her at Charing Cross, particularly, had nothing to damp their satisfaction; the few who returned to Millwall with her were not quite so fortunate; but then it was only that the water just below London Bridge got a little inquisitive, and the top of a wave jumped in to see for itself what made the boat move. That was all. But the consequence was that, although but tyros in electrical navigation an hour previously, we immediately became "wetter uns."

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AN APPARATUS FOR REPRODUCING AT PLEASURE AN INVARIABLE QUANTITY OF ELECTRICITY.

By M. MARCEL DEPREZ.

THE instrument which I have the honour of submitting to the Academy has for its object the easy reproduction, at any time and under any conditions of pressure and temperature, the quantitative unit of electricity which has received the name of the *coulomb*.

It consists of a U-tube, the two limbs of which have been sealed at the lamp and terminate in glass balls, the volume of which is much more considerable than that of the cylindrical portions. One of the balls, as well as the corresponding limb, is completely filled with water, acidulated with phosphoric acid; the second limb contains likewise a little of the same liquid in its lower portion, but in the greater portion of its length it is filled with air at a given pressure, as is also the ball in which it terminates. The limb filled with liquid has four platinum wires fixed in pairs opposite to each other, one pair in the upper part of the ball and the other in the cylindrical portion, a little below the bottom of the ball. If an electric current is directed into the two latter, the water is decomposed and the detonating mixture resulting from this decomposition accumulates in the upper ball whilst the liquid driven into the second limb ascends in it, compressing the air in the second ball. If we take care to note the point of departure of the liquid column in the second limb, which is divided into parts of equal capacity, as well as the point at which it stops on suppressing the current, we have all the data necessary for knowing the quantity of electricity expended in producing the detonating gaseous mixture. It is easy to see that if the volume of this mixture, measured by the rise of the liquid in the second limb is always the same, the quantity of electricity needful for its production will likewise be invariable, and this whatever may be the temperature of the instrument, provided that it is the same in the two limbs, a condition easily realised.

As for the barometric pressure and the hygrometric condition of the air, they have evidently no influence on the result, since the tube is hermetically sealed. Lastly, the liquid being always the same, it will be seen that this instrument allows of the reproduction, whenever required, of a quantity of gas corresponding to an invariable quantity of electricity taken as a standard, the operation consisting simply in reading off a volume, which is always the same, without any correction being required; whilst with the ordinary voltameter, the corrections for temperature, for pressure and vapour-tension can by no means be neglected.

In order that the instrument may serve indefinitely, it is necessary to reconstitute the water decomposed at each operation; this is the purpose of the platinum wires situate in the upper part of the balls where the detonating mixture accumulates. It is sufficient to pass a spark between these wires to induce the combustion of the detonating mixture. The acidulated water again fills the ball, and the instrument is ready for a fresh operation. The apparatus may be made more or less sensitive by filling the second branch before sealing with air of a greater or less pressure than that of the atmosphere.

As to the use of this instrument for graduating instruments intended for electric measurements, I think it is useless to enter into details.

This instrument has been submitted to numerous experiments, in which its indications have been compared with those of the ordinary voltameter, with all the corrections required for temperature, atmospheric pressure, &c. These experiments, made with great care by M. Minet, one of the engineers attached to the experiments at Creil, have shown that the indications of the new apparatus are fully trustworthy.

Electric Lighting of Mills.—The Manchester Edison Electric Light Company is installing 400 lights at the mills of Mr. Robert Platt, of Stalybridge.

THE BLACKPOOL ELECTRIC TRAMWAY.

"A BOROUGH SURVEYOR" has made the Blackpool electric tramway the theme of a discourse to the *Engineer*, and what he has to say thereon will probably be found worth reading, if only as showing the points which the particular genus which the writer represents regard as important to be taken into consideration.

He says: "In the *Engineer* of 1st January last a description of this tramway was given, with illustrations of its principal details. Reference was made to other tramways previously constructed in Ireland and on the Continent in which electricity was used as a means of propulsion, but the line constructed at Blackpool is the first in which electricity has been used in such a way as to meet the requirements of an ordinary street; it is free from the obstruction to traffic which would be offered by an overhead conductor, as at Berlin, or one raised a foot or so above the surface, as at Portrush, in Ireland, and it is free from the inconveniences, and even dangers, attending the use of a conductor exposed in the surface of the streets, as in those systems where the rails themselves form the conductors. In this letter the tramway at Blackpool is looked at from a borough surveyor's point of view, and although some of the remarks made may not seem favourable, it must be understood that they refer to the details of the tramway only, and do not affect its general principle; the criticisms are offered in the hope that they may be serviceable in improving the system, it being the writer's opinion that the best way of perfecting a thing is to eliminate its defects, and that a good way of getting this done is to have the defects clearly pointed out.

"There are good reasons why the opinions of a borough surveyor on tramway matters should differ from those of a civil engineer. The borough surveyor's primary object is the care of the streets, and to see that the tramway does not injuriously interfere with them, nor be a source of danger to the public, nor cause a nuisance or obstruction to ordinary traffic, nor in any other way interfere with the rights of the public to whom the streets belong. It will be readily imagined that the borough surveyor's ideas will not always coincide with those of the tramway engineer on these matters; the borough surveyor will object to many things that the engineer probably prides himself on as models of mechanical perfection, and he may even sacrifice this mechanical perfection if by so doing he can attain other objects which he is bound not to lose sight of. In a public street the best of tramways is always more or less of a nuisance, if nothing worse, except, perhaps, when it is at its best. A rail may stay where it is placed, but a paving stone generally will not, especially when laid adjacent to a rail—it may sink under the weight of ordinary vehicular traffic, and it certainly wears away faster than the rail; so that, however carefully the rail and the stones may have been laid together, sooner or later the rail is found to be projecting above the general surface of the pavement, which consequently has to be taken up and relaid. Now, as the tramway is laid at Blackpool the surface of the road is cut up by three or six, instead of by the two or four rails of an ordinary tramway, according as the line is single or double, and the evil arising from the projecting rails is therefore intensified in the like, if not in a greater, proportion.

"Apart from the question of using three rails instead of two, objection is here taken to the construction of the middle rail or rails forming the top of the tube. The way in which these rails or beams are formed need not be here described, as they are clearly shown in the figures illustrating the article above referred to. The beams are too light in themselves, and too slightly attached to the cast iron frames carrying them and determining the outline of the tube, for them to withstand for long the heavy traffic of a town; and furthermore, there are too many short removable pieces in these beams, forming covers to 'hand holes' for access to the joints in the copper tubes forming the electric main conductor. It may be contended that since it is necessary to have means of access to the joints, it is necessary to have the short removable pieces in the rails; but the rails are under consideration here, not so much as forming a part of the tramway, but as forming a part of the roadway, and as such their construction is objectionable. The form of construction adopted will lead to the disintegration of the joint between the rail and the paving setts, for the beams will deflect and shake loose under the traffic, and the joint will open; the 'racking' and 'grouting' in the joints between the paving setts will be wasted out into the tube below, and the paving setts thereby being left unsupported, will sink under the traffic, leaving the beams or rails projecting above the street surface and forming a serious obstruction to vehicular traffic.

"As the necessity for this method of constructing the top of the tube seems to arise from the method adopted of forming the electric main conductor, viz., of split copper tubes, which can only be obtained in lengths of about 30 feet, and as the use of soldered joints is inadmissible owing to the difficulties arising from expansion and contraction under changes of temperature, it is suggested that the copper tubes be replaced by a copper wire cable, or cables. The cable could be obtained in any length the engineer liked to ask for. It could be supported on hook-shaped insulators within the tube, and by putting a tension upon it, it would be no difficult matter to keep it in its place. Without entering into details, it would seem quite feasible to apply, at such intervals as might be found to be necessary, tension weights attached to a pulley hanging in the bight formed by passing the cable over two insulators—which might also be pulleys—placed close together, as shown in the sketch. The use of the cable and weights, as proposed, would not only get rid of the difficulties arising from

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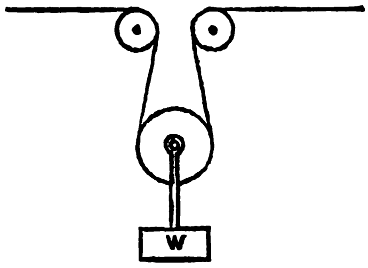
expansion and contraction, but would render the frequent 'hand-holes' in the surface of the street unnecessary. It would also enable the number of insulators to be very largely reduced. Every 'insulator' must be a source of leakage, and therefore



waste, especially in wet weather, and the fewer there are of them the better. The fewer they are in number, the farther the line could be carried away from the dynamos supplying the electricity with a given percentage of loss, and the less power would be required for working the line.

"This question, however, is perhaps more properly the concern of the tramway company's engineer than that of the borough surveyor. But it may be remarked that some years ago water-works companies did not object to a few leaky pipes and defective house fittings. Many of them have since found out that all water pumped into the mains and not used and paid for by their customers has to be paid for by the company themselves, and it is probable that a somewhat similar rule will be found to apply to companies supplying electricity. Repairs to the cable could be performed by drawing it into suitable manholes provided at distant intervals in the streets, or it might even be possible to draw the cable through the tube into the engine depôt.

"Objection must also be taken to the collector—or that portion of the apparatus which connects the motor on the car with the electric main—being dragged along by a cord. It should be a rigid attachment to the car, and strong enough to force aside any obstruction in the slot that could be 'removed by hand.' The breaking of a cord stops the car and blocks the road, and if the driver has not another one to replace the one broken it might cause a serious interruption to the traffic, especially on a single line. Some years of experience of cable tramways shows that the slot is not more likely to get blocked than is the groove in an ordinary rail; and even if the collector itself were not strong enough, or not suitable for clearing away anything that might perchance get into the slot, a strong cow-catcher could be fixed in front of it which could clear the way for it.

"Objection is also taken to the use of wood for forming the sides of the tube. However carefully the wood may be creosoted or pickled, it will not for long stand the heterogeneous nature of the liquids to be found on the surface of a town street. Sooner or later it will decay and cause the collapse of the sides of the tube and the sinking of the surface of the road.

"The last objection, but by no means the least, must be to the middle rail itself, or rather, to putting the tube containing the electric conductors in the middle between the two ordinary rails of the tramway. It will be seen that in some respects this tramway resembles a cable tramway, but on a cable line there is a good mechanical reason for putting the cable tube in the centre: if it were put elsewhere the gripper would cause an oblique pull on the car, and a side pressure on the flanges of the wheels and on the rails. Whatever may be the force of this reason on a cable tramway, it cannot apply to an electric tramway, since the collector, which replaces the gripper, is not used to transmit a mechanical force. If the tube containing the electric main were placed under one of the rails of an ordinary tramway—and by preference, under the rail on the 'near' side, or under the two outer rails on a double line—and the slot were to open into, and in fact form, the groove of that rail, we should have all the things really essential to an electric tramway, and we should only have the surface of the street cut up by two rails for each line instead of by three. The rail would have to be strong enough to carry the tramcar, and the type of construction used at Blackpool would not be suitable; but there should be no difficulty in designing a rail that should be strong enough vertically to carry loaded cars without sensible deflection, and stiff enough laterally to support the paving setts, and maintain the proper width of the slot."

THE INDIAN AND COLONIAL EXHIBITION.

ON Tuesday last, May 4th, the Indian and Colonial Exhibition was opened by a most imposing State ceremonial, the Queen, the Prince and Princess of Wales, and many other members of the Royal family being present, attended by a large number of high dignitaries of Church and State, Indian and Colonial representatives, and others. The aspect of the whole place is changed since the close of the last show, every colour and every degree and style of decoration appearing to have had free play, the result giving a most striking air of novelty and comprehensiveness. The Inventions Exhibition having worn a somewhat sombre and matter of fact aspect, the contrast is all the more remarkable. The electric lighting continues to be one of the attractions, and was in full operation on the opening night, but the old arrangements are altered to a considerable extent. In the electric light shed a great clearance has been made, the only companies now in possession being the Anglo-American Brush Corporation, Messrs. R. E. Crompton & Co., the Pilsen-Joel, and the Edison and Swan. Altogether, there are about 30 machines of various types in the shed, driven, as on former occasions, by the engines of Messrs. Davey, Paxman & Co. But, in addition to the machinery in this building, Messrs. Galloway and Sons have in a shed specially allotted to them two of their powerful horizontal engines, driving four large Elwell-Parker dynamos. These are for the lighting of the gardens and fountains, which last year was undertaken by Messrs. Siemens. The lighting of the dining room by Edison-Swan lamps, under pink shades, is much admired, and the substitution of arc for incandescent lighting through the large galleries is, on the whole, an improvement. A small building has been put up in the South Promenade to accommodate storage batteries of the Electrical Power Storage Company, for the lighting of the Subway, the Club Dining Room, and some other departments. The number of arc lights this year is about 400—namely, 160 Brush, 140 Crompton, and 100 Pilsen.

NOTES.

Temporary Electric Lighting.—The electric lighting at the festivities at the Duke of Newcastle's Clumber estate, held in honour of the coming of age of the Duke, was carried out by Blakey, Emmott & Co., of Halifax. Judging from the reports in our daily contemporaries the electric light added greatly to the enjoyment of the visitors to Clumber. In the ball-room, which accommodates 600 guests, some very elaborate chandeliers were ranged down the centre of the room, and supplied with incandescent lamps; along the sides of the room on each side, and over the various mirrors drop pendants and brackets were freely distributed. A large candelabra in the drawing-room carried 30 lights, while the smaller rooms were also lighted. Ranged about the mansion outside and at the stables, &c., were a number of Pilsen arc lamps and on the top of the mansion was fixed a search light of 6,000 candle-power, so arranged that its rays could be directed in any direction over the vast estate. The dynamos consisted of five Blakey-Emmott machines, driven by a Marshall's engine. We congratulate Messrs. Blakey-Emmott on the manner in which they carried out the work.

The silver wedding of Lord and Lady Revelstoke at Membland, Revelstoke, was celebrated, among other festivities, by a ball in a large tent in the grounds, which was brilliantly illuminated by numerous incandescent electric lamps.

The Electric Light at Sea.—Lord Alfred Churchill recommends that the electric search light now in use on war-ships should be kept at work at night by all passenger steamers on much frequented routes. The cost could not be great; but were it ten times more than it is likely to be, it is considered that it would be amply repaid by the security which this beneficent invention would give to all who travel by sea.

Mr. Bernstein's Paper on Glow Lamps.—The Bernstein Electric Lamp Company informs us that there were several inaccuracies in our report of Mr. Bernstein's reply to the remarks made during the discussion on his paper upon "Low Resistance Glow Lamps," and offers to send us a correct copy of Mr. Bernstein's reply; this we should be glad to receive.

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Too Much Light on Brooklyn Bridge.—The beautiful arch of electric lights upon the Brooklyn Bridge has, from the beginning, it is alleged, given offence to the pilots of the river craft, who maintain that the great brilliancy blinds them and renders the lights of vessels indistinct. Recently a maritime journal drew attention anew to the subject, and asserted that not until a collision occurs will the evil be remedied. These opinions from parties who have no ill-will toward the electric light, says the *Electrical World*, deserve consideration, and if the lights are a source of danger steps should be taken to render them harmless to the sailing fraternity. A very simple remedy is at hand, which, although it may detract from the beauty of the scene, would nevertheless be effective. The remedy lies in merely enclosing the lamps in hoods or screens so that their light should only be shed upon the bridge, cutting off their rays in all other directions.

The Newspapers and the Electric Light. — The *Citizen*, the other day, committed itself, as many other newspapers have done, when discussing electric light matters. Mr. A. L. Fyfe has given our contemporary some slight information on points regarding which it was evidently in the dark, and possibly it may now believe that the prospects of the electric lighting industry are a little brighter than it had imagined.

Electric Lighting of a New College.—Messrs. B. Verity & Sons have obtained the contract for lighting the new Holloway College, at Egham, which is to be opened by the Queen in June. Over 500 16-C.P. lamps are being installed. The current will be generated by two Edison new form dynamos, each of 500 light capacity.

The Portsmouth Telephone Exchange.—A tribute to the value of this exchange was fittingly rendered at the last meeting of the Chamber of Commerce, which includes in its membership the most important business men of the town. The Hon. Secretary, Mr. W. Edmonds, stated that the system had now been in operation for about twelve months, and 64 subscribers were connected. Commercially speaking its value could not be over rated. He understood that it was contemplated that they would shortly have depôts established in different parts of the borough for the convenience of subscribers.

Telephone Extension in Scotland.—The National Telephone Company has resolved to proceed with the erection of trunk lines from Dundee to Glasgow, with branches to Edinburgh, &c.

Underground Telephone Wires.—The Bell Telephone Company's report shows that 2,203 miles of telephone wire were put under ground last year in the cities of Washington, Chicago, New York, Pittsburg, Boston, Brooklyn, Baltimore, and Milwaukee. There are now 3,428 miles of wire under ground in these cities, the amount being proportioned not to the size of the cities so much as to the amount of pressure put upon the companies for the abatement of the overhead wire nuisance.

An Arrest by Means of the Telephone.—Shortly before four o'clock on Thursday morning, last week, a housekeeper on the premises occupied by Messrs. Bennett and Roach, Queen Square, Bristol, called the attention of the telephone operator to the fact that there were burglars in the house. The operator immediately communicated by telephone with an officer at the sessional court-house in Bridewell Street, and explained the singular nature of the message which he had received. He was informed that assistance would be sent without delay, and, about an hour after, an inquiry by telephone received the welcome reply that the constables who had been despatched to Queen Square had succeeded in making an arrest. The burglar was sentenced to three months' imprisonment.

The Telephone and Lightships.—At a meeting of the Ramsgate Town Council held the other day, the question of taking steps to establish telephonic communications between lightships on the Goodwin Sands and that town, was discussed. It was decided to let the matter stand over until after a meeting which is shortly to be held, and which will be addressed by Colonel King-Harman, M.P., has taken place, and then a deputation is to be formed to wait upon Mr. Mundella, the President of the Board of Trade.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to May 1st, 1886, amounted to £135,000, against £140,000 received from April 1st to May 2nd, 1885.

Why the Commercial Cable Thrives.—The following letter which appeared in the *Times* City article, refers to the struggle between the Atlantic Cable "pool" and the Mackay-Bennett Company:—"I see it stated in some newspapers that one of the reasons for the cut in cable rates is the allowance by the Mackay-Bennett Cable of rebates to large customers. I think this accusation is not justified by the facts. Apart from certain advantages that a cable running right into New York city possesses, there are thousands in that city who will go out of their way to benefit any enterprise that is run in opposition to Jay Gould and his clique. Actuated by both the above considerations, I some time ago requested all my firm's correspondents who were in the habit of cabling us to give the preference to the Mackay-Bennett cable. They have done so, and, as our cables sometimes cost $100 a day, we may be supposed to receive a rebate. This we have never received, have never asked for, and never expect to receive the offer of.—NEW YORKER."

German Cable Charges.—The German Postmaster-General announces that from May 5th the charge for all telegrams sent from Germany to all the more important centres of the United States and Canada by the German cable, *viâ* Emden and Valencia Island, will be reduced until further notice from 1 m. 65 pf. to 65 pf. a word—a reduction of 1 m., or 1s., on each word. At the same time a corresponding reduction of charge will be made for telegrams to Mexico, as well as to Central and South America.

Cable Rates to South America.—The Eastern Telegraph Company, Limited, notifies that by arrangement with the Brazilian Submarine Telegraph Company, Limited, the rates to South America will, on and after 5th inst., be materially reduced. The reductions vary from 2s. to 3s. per word.

A New Light.—A general meeting of the Philosophical Society of Glasgow was held last Wednesday week in the rooms of the society, Bath Street, Dr. Henry Muirhead, president, in the chair. Mr. J. B. Hannay, F.R.S.E., described a new industrial light. He explained that it was produced by burning natural mineral oil, the product from gas works, or the oil from blast furnaces or coke ovens under pressure, in the form of a jet of spray, or in conjunction with heated air or, where procurable, dry steam. The flame had an illuminating power of 2,600 candles, and was useful for the illumination of large open air space or workshops. A one horse-power air compressor would supply power for eight lamps, giving 20,000 candle-power, or an eighth of a horse-power for each lamp. The original cost of the appliances was calculated to be about one-fourth of that necessary for the production of the electric light, which it was found to surpass for industrial purposes, as it did not cast such strong shadows. In the course of a discussion which followed, Mr. Foulis, manager of the Glasgow Corporation Gas Works, said there was no doubt that the new lamp would have a very great future. Mr. Hannay exhibited specimens of the appliances by which the light is produced, and showed one of the lamps burning in the lane behind the Philosophical Society's building.

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Weston System of Domestic Lighting.—On the 21st ult., Mr. Hugh Watt, M.P., Chairman of the Maxim-Weston Electric Company, received a number of the shareholders and other gentlemen at his private residence for the purpose of exhibiting and explaining the new Weston system of incandescent lighting. Throughout the principal rooms of the house there are 30 incandescent lamps; the dynamo and a 2½ horse-power gas engine being located in a small outhouse in the basement. As an illustration of what may be done in a town house where there is not much spare room, the installation is an interesting one, and the light during the evening referred to was fairly steady and satisfactory.

The Electric Tramway on Ryde Pier.—Very satisfactory accounts reach us of the working of the electric tramway, which was a short time since established on Ryde Pier by Messrs. Siemens & Co. On grounds of economy, speed, and comfort, it has more than realised the anticipations of the directors, who, in spite of a somewhat vigorous opposition, were wise enough in the first instance to advocate electricity, as opposed to other motive powers. During the Easter holidays there were as usual a large number of visitors to Ryde, and the novelty of a tramway propelled by an "unseen force" proved a great source of attraction.

Electrical Staffs for the Dockyards.—The action of the Admiralty in directing fitters from other dockyards to be sent to Portsmouth for instruction in electricity, would appear to point to an intention—long since expected—on the part of the authorities of giving as little of their work as possible to private electrical firms. Of course, the numerical strength of the present dockyard electrical staffs would not be sufficient to enable them to carry out the work of fitting large vessels with the electric light, but they must rather be considered as a nucleus for future enlargement. It is not certain that firms like Messrs. Siemens would be much the losers were the work of fitting vessels of the Royal Navy taken out of their hands entirely. They would still have to supply the the apparatus; and, after all, that is the most lucrative part of the business.

Electricity in the Navy.—The *Scout* at Portsmouth is shortly to be fitted with the electric light, the dockyard authorities having been directed to forward to the Admiralty an estimate of the cost for carrying out the same. Last week successful trials of the electric light were made on board the *Phæton* in the Medway. Early next month the *Phæton* is to leave Chatham. Some experiments with the Ericsson submarine gun are shortly to take place at Portland, under the supervision of Lieut. Gladstone, who visited the inventor when on the North American station. A platform is being erected for the gun, which will be so placed as to be dry and easy of access at low tide, and be covered with 10 or 12 feet of water during two or three hours of each other tide, when the experiments will be carried out.

An Electric Clock.—The work of fitting the electric clock at Mount Wise, by which the circuit will be "closed" direct from Greenwich and the one o'clock gun thus fired punctually, is being hastened as far as possible, under the direction of the Devonport Dockyard authorities. It is proposed to make considerable use of the new appliance. By arrangement with the Admiralty and Board of Trade, not only ships of war, but also merchantmen will be able to get Greenwich time on arriving in the Sound, by signalling for that purpose. This will be a great boon.

Sudden Death.—On Friday night last, at the office of the National Telephone Company in St. Andrew Square, Edinburgh, Mr. W. D. Chaffers, who was in the employment of the company, dropped down dead. He had been seized by a bleeding at the ear, and died shortly afterwards; the cause of death being hemorrhage of the lungs.

The German Edison Company for Applied Electricity.—At the annual meeting of this company, held April 29th, the report presented speaks of considerable progress. The balance sheet shows a clear profit of 380,481 marks, 37 pfennigs, or in round numbers, £19,024. From this sum 110,000 marks are deducted for an extraordinary reserve fund, and 250,000 are divided among the shareholders, being five per cent. on the capital of 5 million marks. During the course of 1885, 129 machines for 22,000 glow lamps and 500 arc lamps have been installed on the company's system. This is a notable advance on the year 1884, in which only 13,000 glow lamps were put up. In addition certain licensees of the company, including the firm of Siemens and Halske, have installed 13,000 lamps. The electric light has been introduced in the theatres of Stuttgart, Munich and Berlin, and is about to be adopted in those of Schverin and Dessau. The company has entered into an arrangement with the Prussian Department of Education to light up the University of Berlin.

Prof. Hughes on Self-Induction.—There was a misprint in Mr. James Swinburne's letter in our last week's issue, "$f\,t\,d\,e = f\,t\,d\,e'$" should have been "$\int t\,d\,e = \int t\,d\,e'$."

Gas v. Electricity.—At the ordinary meeting of the Institution of Civil Engineers on Tuesday last a paper on "The Mersey Railway," by Mr. Francis Fox, M.I.C.E., was read. In it the writer says:—"The stations were lighted with gas, as the author was of opinion that, so long as the smallest uncertainty existed as regarded the regularity of electric lighting, a railway company was not justified in employing electricity as a lighting agent, unless gas was also laid on, so as to be readily available in case of break down of the electric lighting machinery."

An Electric Launch Trial Trip.—On Wednesday last the final trial trip of the launch, which we speak of at length in our other columns, took place. The test was over the measured mile at Greenhithe, at the same speeds as mentioned on p. 423. The representative of the Italian Government was present, and declared himself to the effect that the results exceeded his greatest anticipations. The launch is now awaiting shipment to its destination, and we heartily congratulate Mr. Reckenzaun on the success he has so far achieved in this branch of electrical engineering, which we hope may rapidly develop under his fostering care.

Messrs. Yarrow & Co., who constructed the hull, and Messrs. Stephens, Smith & Co., the engineers who built and fitted the Reckenzaun apparatus to her, must also experience considerable pleasure at so successful a termination to their labours. We must not forget to add that the secondary batteries were supplied by the Electrical Power Storage Company.

The Society of Telegraph Engineers and Electricians.—The next meeting at 25, Great George Street, S.W., will take place on Thursday, May 13th, 1886, at 8 p.m., when a paper on "Long Distance Telephony," by W. H. Preece, F.R.S., past president, will be read.

Death of the Maker of the First Telegraph Instrument.—The *Telegraphist* announces that the veteran mechanic, Mr. John Brittan, who made the first telegraph instrument, contrived by the late Sir William Fothergill Cooke, died at Luther Cottage, Odd Down, Bath, on February 2nd, 1886, in the 76th year of his age.

The "Great Eastern."—This famous ship left Milford Haven for Liverpool last week. Those on board had an adventurous journey, as the engine broke down for a time, and, later, an alarm of fire was raised. The outbreak did not prove serious, and was soon subdued. The *Great Eastern* will remain in the Mersey during the Maritime Exhibition, and will afterwards, it is stated, be used as a coal hulk.

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The Journal of the Society of Telegraph-Engineers.—The following are the contents of No. 60 of the journal of this society, which has just been issued:—Inaugural Address of the President (Prof. Hughes); discussion on the address. Original Communication:—"A simple method of preventing the inconvenience caused by the acid vapour carried into the air when hydrogen gas is evolved from acidulated water," by F. Higgins. Abstracts:—"Theory of the electro-magnetic telephone receiver," by E. Mercadier; "The transformers of Blathy, Deri, and Zipernowski," by W. C. Buhniewski; "Electric and thermic properties of saline solution," by J. Moser; "The source of ordinary atmospheric electricity," by Sohncke; "Experimental researches on the specific inductive capacity of some gases and vapours," by J. Klemencic; "On the discovery of Mr. Fritt's of the electromotive action of illuminated selenium," by W. Siemens; "Peltier's phenomenon in liquids," by E. Nacarri and A. Bartelli; "Underground cables of the Nuremburg telephone system," by E. Bieringer; "Explanation of the differences between Frölich's theory of the dynamo and his own," by R. Clausius; "Results of the magnetical and meteorogical observations made at the Royal Observatory, Greenwich, in the year 1883," by Wm. Ellis, F.R.A.S. At the end of the number is a list of articles appearing in the principal foreign technical journals.

The Edinburgh International Exhibition.—The opening ceremony in connection with this exhibition was announced for yesterday (Thursday), in the presence of Prince Albert Victor. In the open court between the two northern sections the Post Office is situated, and here the whole branches of postal, telegraph, and money order business will be conducted.

For lighting purposes, the exhibition has been divided into six sections, every one of which, with one exception, is to be served by a different firm of contractors. In the main avenue there are 1,444 incandescent lamps of 20 candle-power each. Messrs. King, Brown & Co., Rosebank, Edinburgh, show fourteen dynamos, driven by four vertical engines, by Marshall, of Gainsborough. These dynamos provide the 1,400 incandescent lights in the central court and 1,200 in the grounds outside. The Thomson-Houston system is worked by Mr. Richard Miller, Glasgow, who has seven dynamos, four of which supply the permanent building with 67 arc lamps, two the north-west court with 80 lamps, and the other is for the outside illumination of the main entrance. These dynamos are driven by two of Robey's engines, of 30 and 40 horse-power respectively. The Gulcher Company has four dynamos supplying 32 arc lamps in the south-west courts, and the incandescent lamps in the reception rooms and offices in the permanent pavilion. The coupling switches of this system are so arranged that, should any circuit break down, the machine can be cut out and one of the others put on. The Anglo-American Brush Corporation has four dynamos for 55 arc lights in the north section, and they have also two Victoria machines for lighting Old Edinburgh with 250 incandescent lamps. Messrs. Andrews & Co., Glasgow, have the largest dynamo in the exhibition, weighing over five tons, and it provides for 33 arc lamps. They have a second dynamo, which they are keeping in reserve in case of accident. The permanent building will be lighted with 150 arc lamps, and in front of the main entrance there will be other six arc lamps. On the northern promenade there will be 32 arc lamps, each of 2,000 C.P., and suspended from eight masts 50 feet in height. Old Edinburgh will be illuminated by 250 incandescent lamps; and in the machinery section there will be 32 arc lamps of 2,000 C.P. each. In all, there will be about 3,150 lamps, giving a light of 570,000 C.P. The grand hall and picture galleries will be bathed in a flood of light equal to that of 130,000 candles, and the central court will enjoy a light equal to that of nearly 29,000 candles.

The electric railway has been laid down along the northern promenade, and two fine cars have been supplied for it, free of charge, by the North Metropolitan Tramway Company, London.

The Crompton Dynamo Tests.—There are several points in the letter of Mr. Sidney F. Walker which deserve attention. We begin to doubt whether any good purpose has been served by the publication of these tests, which appear to be more or less meaningless. We found several weak points in the report, but Mr. Walker goes further still, and proceeds to demolish it almost entirely.

The Strange History of a Dynamo.—We are requested to inform a "South Hackney Correspondent" that the commutator illustrated last week was intended as a typical representation, and that such machines as those of Pixii or Clarke are of no use for the purpose he mentions. We imagine that Messrs. J. and E. Dale could supply our correspondent's requirements.

Dr. Stone's Lectures.—In this issue the Lumleian lectures of Dr. Stone come to a conclusion. The perusal of these must have been specially interesting to both electricians and medical men, for the author has gone more deeply into his subject than has hitherto been done.

Winding Magnets for Dynamos.—We publish this week the fourth paper of Mr. Carl Hering on winding magnets for shunt, series and compound machines. These articles, as our readers are already aware, have been appearing in the recent numbers of our esteemed contemporary the New York *Electrical World*.

The Blackpool Electrical Tramway.—"A Borough Surveyor," in his comments upon the construction of Mr. Holroyd Smith's Blackpool line, suggests that the conductor should be placed beneath one of the rails, the current collector passing through the groove between the two portions of the rail. In a paper on the "Electrical Propulsion of Vehicles," published in the April number of the *Bulletin de la Société Internationale des Electriciens*, we find the above suggestion has been carried out in the system of M. Berlier. Those interested in this very important application of electricity should read the article to which we refer.

City and Guilds of London Institute.—At the Central Institution, Exhibition Road, Professor Ayrton continues his course of lectures on "Some of the Industrial Applications of Electricity," on Friday week, May 14th, at 5 p.m. The subjects for May 14th and 21st are "The Electric Transmission of Power," and on May 28th "Electric Locomotion." The following gives the subjects more in detail:—May 14th and 21st, "Electric Transmission of Power." Waste of power in the conductors; advantages and disadvantages of the parallel system of supplying electric power; economy effected by the use of the series, or the parallel-series system; most economical size of conductors; heating of conductors; uniform potential difference, or uniform current, along the mains; use of accumulators, secondary generators and motor-dynamos, in electric transmission of power; practical results already obtained with electric transmission; comparison of electric with hydraulic and wire-rope transmission of power. May 28th, "Electric Locomotion." Tramcars carrying a store of electric energy; electric launches; methods of conveying electric power to moving vehicles; electric, steam, horse, and wire-rope traction; absolute blocking with electric railways; telpherage. Probable future developments in the applications of electricity. The number of students attending the course is about 80.

Magnetising Watches.—Mr. J. Jerritt, A.S.T.E. & E., writing from Plymouth, says:—"Will any of your scientific readers kindly inform me whether they consider the magnets in magnetic appliances—such as a belt or chest protector—sufficiently powerful to magnetise an ordinary watch?"

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Electric Locomotion.—Mr. A. J. Jarman writes to us, too late, however, for our correspondence columns, as follows:—"I notice in your last issue of the ELECTRICAL REVIEW that a trial trip has been made with one of the electric locomotives of the Electric Locomotive and Power Company, but it does not state the number of passengers upon and in the car, nor the amount of electrical energy employed to *start* and to keep in motion both the car and locomotive. I believe that it was by my advice, when I was the manager to the late Jarman Electrical Company that Elieson's plan of transmission was tried. It was also the suggestion of the late Dr. Stephen Monckton, of Maidstone, to convert this mechanism into a locomotive. While the electro-motor itself is the design of an electrical engineer, whose name deserves to be better known than it is, because of his sound, practical and mathematical knowledge in connection with electricity; I allude to Mr. Fredk. Walker, of Tottenham, I notice that your account states that *the engine carried* 70 *cells*. Was this all? When the trial was *first* made at the works at Homerton it required 13 cells to *set the locomotive and its mechanism alone in motion*. I would venture to say that if the whole of the facts were known that with a half loaded car it would require not less than 130 ampères at 150 volts to start. I am convinced that with this locomotive the energy of 13 storage cells at the least is wasted upon the locomotive itself and consequently the cost of those 13 cells also. I think the thanks of all your readers are due to Mr. Reckenzaun, who has pointed out in such a very clear and straightforward manner the essential points to be considered in the application of electricity to locomotion. With regard to the various plans of transmission I have had some experience with Mr. F. H. Danchell's plan by friction, and also by radial toothed gearing, but I am of opinion that neither of these plans are the best adapted for the purpose. I know that by the latter plan when a test was made it took 17¾ electrical H.P. to develop 4 H.P. upon the driving axle. I am sure that very many of your readers besides myself would like to know more about the success of this locomotive (not financially, for this is assured, at least to one section of the company) in comparison with the cost of propulsion by horses, for I am quite confident that if this electric locomotive can be made to compete in save of cost compared with horses, success *must* attend a good sound and efficient plan that can be applied to the car *itself*, and thus do away with the locomotive, its cumbrous mechanism, and useless weight."

The Oppermann Failure.—The public examination of C. T. J. Oppermann, twice adjourned, was continued at the Bankruptcy Court yesterday (Thursday) before Mr. Registrar Hazlitt. In reply to Mr. Cooper-Willis, who appeared for the trustees, the bankrupt stated that he was now in the employ of his brother, a minor, who was engaged in a business somewhat similar to that which he (the bankrupt) had previously conducted. His brother managed the business, and paid him £3 weekly. He did not keep his brother's books, nor did he know anything of his affairs. The bankrupt was not discharged, but the examination was adjourned *sine die*, as the brother who was a partner in the business and lived in Chicago, carrying on a branch there, had not surrendered to the Court.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Western Counties and South Wales Telephone Company, Limited.—The annual return of this company, made up to the 8th ult., was filed on the 30th ult. The nominal capital is £400,000 divided into 20,000 preference shares of £5 each and 300,000 ordinary shares of £1 each. The shares taken up are 10,000 preference and 275,000 ordinary. Upon 6,600 preference shares £2 per share has been called, and £5 is considered as called upon 3,400 shares, and the full amount is considered as called upon each of the 275,000 ordinary shares. The calls paid (including £898 paid in advance of calls and £10 on forfeited shares), amount to £13,828, leaving £280 unpaid.

An extraordinary general meeting of the company was held on the 25th March, when resolutions were passed altering the articles of association to enable the company to borrow money, but so that not more than £6,000 be owing at any time without the consent of general meeting and providing that not more than £2,000 of such money be borrowed without the consent of the United Telephone Company, Limited, nor without such consent to carry more than 6 per cent. per annum interest. It was also resolved that the directors appoint the remuneration of the first auditors, and that the company in general meeting shall fix the remuneration of subsequent auditors. These resolutions were confirmed on the 14th ult., and duly filed on the 30th ult.

NEW COMPANY REGISTERED.

Hydrogen Amalgam Company, Limited.—Capital, £200,000 in £1 shares. Objects: To enter into agreements to purchase and deal with mineral, chemical, and electrical properties and inventions of every description. Signatories (with one share each): *J. G. Johnson, 23, Cross Street, Finsbury; *B. C. Molloy, M.P., 3, Elm Court, Temple; *F. W. Browne, 30, Wood Street, E.C.; C. Colladon, Twickenham; S. W. Spratt, 43, Queen Victoria Street; A. Brogdon, J.P., 9, Victoria Chambers, S.W.; T. Wakefield, Croydon; J. C. Castro, M.D., Torquay. Directors' qualification, 200 shares; the signatories denoted by an asterisk are the first directors. Registered 4th inst. by Messrs. Smiles & Co., 15, Bedford Row.

CITY NOTES, REPORTS, MEETINGS, &c.

The Brazilian Submarine Telegraph Company, Limited.

THE Report of the directors for the half-year ended 31st December, 1885, states that the revenue for this period amounted to £77,066 0s. 10d., and the working expenses to £12,893 5s. 5d. After providing £9,680 for debenture interest and sinking fund, and £1,199 15s. 4d. for income tax, there remains a balance of £53,293 0s. 1d.; to this is added £2,830 16s. 3d., brought forward from 30th June last, making a total of £56,123 16s. 4d. First and second interim dividends amounting to £39,000 have been paid, and £15,000 transferred to the reserve fund, leaving the sum of £2,123 16s. 4d. to be carried to the next account.

The message receipts for the half-year amounted to £76,825, which shows a decrease of £12,178 when compared with the receipts for the corresponding period of 1884. This large decrease has been caused principally by the depressed state of trade and the decline in the rate of exchange. With respect to the latter, the directors are glad to report there is now a marked improvement in the exchange value of the Milrei.

All the company's cables are in good working order.

Acting under the authority given by the shareholders to the Board at the extraordinary general meeting held 21st January last, this company has joined with the Eastern Telegraph Company, and the Telegraph Construction and Maintenance Company, in the formation of the African Direct Telegraph Company. That company's cable from St. Vincent to Bathurst, on the African coast, is already laid, and will shortly be ready for traffic; the other cables are in a forward condition of manufacture, and it is expected that they will be laid and in operation during the present summer. The interest of the Brazilian Company in the telegraphic communication with the West Coast of Africa is very important. The line will be worked at St. Vincent in this company's station, and it is agreed the telegrams between England and Africa for and from the African Direct Telegraph Company's system shall be conveyed by the cables of the Brazilian Company between St. Vincent and Lisbon, and by those of the Eastern Company between Lisbon and London.

Submarine Cables Trust.

THE report of the trustees for the financial year, to April 15th, 1886, states that the revenue for this period, including the balance brought from the previous accounts, viz., £1,949 16s. 8d.

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and including the dividend on the Eastern Extension shares referred to in the last report of £2,987 11s., amounted to £23,776 5s, 6d. The expenses of the Trust for the twelve months amounted to £1,349 14s. 10d. The payment of two half-yearly coupons at the rate of 6 per cent. per annum absorbed the sum of £20,286, leaving a balance of £2,140 10s. 8d. to be carried forward. The decrease of revenue this year has been entirely owing to the diminished dividend paid by the Anglo-American Company, in consequence of the competition with the Commercial Cable Company. The securities held by the trustees remain unchanged. Particulars of the original and present investments of the Trust are given as usual in the table which follows this report.

India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—A settling day and quotation have been appointed by the Stock Exchange Committee for the £200,000 4½ per cent. debentures of this company.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of April was 3,981, estimated to produce £3,300, against 4,319 messages, producing £3,886 in the corresponding month of last year. The receipts for the month of January, estimated at £2,850, realised £2,891.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th April are £2,435, as compared with £3,857 in the corresponding period of 1885. The January receipts, estimated at £5,484, realised £5,477.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 30th were £2,551, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for April, 1886, were £19,800; from January 1st to April 30th, 1886, £78,480; in the corresponding months, 1885, £89,200; and of 1884, £81,640.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April were £1,597, against £1,510 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for April amounted to £47,611, against £63,085 for the corresponding period of 1885.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending April 30th, were £3,225.

NEW PATENTS—1886.

5817. "Galvanic batteries." S. F. WALKER. Dated April 29.

5823. "Telephone receivers." J. L. CORBETT. Dated April 29.

5824. "Telephone transmitters." J. L. CORBETT. Dated April 29.

5825. "Telephonic apparatus." J. L. CORBETT. Dated April 29.

5839. "Transforming or converting electrical energy; apparatus therefor." E. CONRY. Dated April 29.

5855. "Galvanic battery." F. W. BRANSON. Dated April 30.

5878. "Automatic electric switch for controlling the current passing between the generator and secondary batteries, and for cutting out lamps, &c." J. RADCLIFFE. Dated April 30.

5884. "Thermopiles." H. W. COOK. Dated April 30.

5932. "Running and burning work of a magnesium lamp with electrical self-winding up." H. HEINE and SOHN. Dated May 1.

5940. "Telephones." P. GANNON. Dated May 1.

5962. "Incandescent electric lamps." T. J. HANDFORD. (Communicated by E. H. Johnson.) Dated May 3.

5971. "Electrical batteries and appliances." A. W. ARMSTRONG. Dated May 3.

5979. "Incandescent electric lamps." B. J. B. MILLS. (Communicated by W. Holzer.) Dated May 3.

5985. "Applying electricity to illuminative and other purposes in theatrical and analogous representations." MARY MCMULLIN. Dated May 3.

5993. "Electro-magnetic retouching pencils for photographic purposes." H. J. HADDAN. (Communicated by L. Fried and B. Iscovits.) Dated May 3.

6027. "Recording and reproducing speech and other sounds." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6035. "Receivers, apparatus and circuits for telephone communication." A. J. BOULT. (Communicated by W. Marshall.) Dated May 4. (*Complete.*)

6042. "Reproducing sounds from phonographic records." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6044. "Magnetophones." F. H. BROWN. Dated May 4. (*Complete.*)

6047. "Reproducing speech and other sounds by means of records." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6062. "Transmitting and recording sounds by means of radiant energy and means and apparatus therefor." J. Y. JOHNSON. (Communicated by the Volta Graphophone Company.) Dated May 4. (*Complete.*)

6075. "Galvanic batteries." A. Héguilus. Dated May 4.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3467. "Improvements in dynamo-electric machines." A. M. CLARK. (Communicated from abroad by L. Vissière, of Marseilles.) Dated March 17. 11d. Has for its object an economical mode of construction whereby to utilise, under the most favourable conditions, the material employed and obtained from the mass the maximum effect, regard being had to the different strains which they have to support.

3805. "Electric governors." J. SWINBURNE. Dated March 24. 6d. According to this invention a dynamo-electric machine is controlled as to electromotive force or as to current by altering the current round the field magnets, or by altering the speed of the driving engine, or the electromotive force on any particular part of a circuit is regulated, as when a batch of glow lamps is to be kept under uniform electromotive force when they are as a batch in series with arc lamps or with other batches of glow lamps. Thus if a direct current machine is wanted to give a constant electromotive force or pressure with a varying load, and perhaps a badly-governed driving engine; suppose the machine to be shunt-wound, the field magnet coils are put in circuit with a liquid resistance which admits of a gradual alteration. The resistance can be made by so arranging platinum or lead plates in dilute acid that the resistance of the route the electricity takes going from one to the other can easily be varied within wide limits. The plates may themselves be movable and may be separated or brought nearer each other, or they may be stationary while the conducting path between them is altered by the interposition of some insulator. A simple way is to make one electrode a rod and the other a hollow cylinder round it, and to allow a tube of xylonite, celluloid, or glass to be brought up between them to increase the resistance.

3942. "Electric measuring instruments." J. SWINBURNE and S. EVERSHED. Dated March 27. 6d. To make an instrument according to the invention coils may be used as in the instrument well known as Weber's dynamometer, where the current in a fixed coil acts on a movable coil also with current, so that the current or currents may be measured by measuring the force or forces acting on the movable coil. The force tending to move the movable coil may be opposed by the force of gravity. Thus the movable coil may be mounted on an arbor whose axis is not vertical, and the centre of gravity of the system may be arranged so as not to be in the axis of the pivot.

4286. "Improvements in or connected with moderators for electric lamps." E. L. ROUSSY. Dated April 7. 8d. Relates chiefly to a current regulator consisting of carbon powder which is compressed by a screw, previously described in the REVIEW.

4468. "Improvements in electric railway systems." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated April 10. 8d. The object of the invention is to produce an economical and efficient system for utilising electricity as the motive power in railways; and the invention consists in the various novel arrangements and devices employed in accomplishing the above-named object.

15701. "Improvements in the insulation of electric aerial line wires." A. E. GILBERT. Dated December 21. 6d. Has reference to a new shackle insulator.

1886.

154. "Improvements in dynamo-electric machines and electric motors." H. J. ALLISON. (Communicated from abroad by Elihu Thomson, of America.) Dated January 5. 8d. The principal object of the invention is to secure a simple and efficient dynamo-electric machine adapted to furnish a constant potential, or nearly so, and an electric motor for the purpose of maintaining, when fed by a current of constant potential, a nearly constant speed.

337. "Improvements relating to the electrical transmission of sound." W. R. LAKE. (Communicated from abroad by J. W. Bonta, of America.) Dated January 8. 8d. Consists in transmitting vocal articulations and other sounds over a line or secondary circuit by electric currents induced by varying, as well as breaking, the contact between two electrodes in the primary circuit associated with the said secondary circuit.

993. "An apparatus consisting of a combination of an electric alarm bell attachment to a hook or peg, or hooks or pegs, used for hanging or suspending goods or other articles." S. P. WESTON. Dated January 22. 4d. Consists of an apparatus consisting of a combination of an electric alarm bell attachment, so adjusted to a hook or peg, or hooks or pegs, used for hanging or suspending goods or other articles so arranged that when any such goods or articles are displaced or removed, an electric contact is made which closes an electric circuit in which an electric bell and battery are placed, thus giving an alarm by ringing the bell.

1151. "Improvements in galvanic batteries." W. W. POPPLEWELL. (Communicated from abroad by F La Otis Lathrop, J. W. Carter, and C. Faber, all of New York.) Dated January 26. 8d. The invention consists of a metallic jar or cell, that is lined at the interior with rubber or other acid-resisting material, said rubber lining being extended over the edge of the jar, of a porous cup provided with enlarged rounded ends and parallel sides that

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approach closely to each other, a zinc made in the form of a screw with one or more threads, and provided with a depression or pocket at its top part that communicates by a hole with the screw thread, so as to supply the mercury for amalgamating the zinc while in use, and without removing it from the jar, and of carbons made in the form of plates, and provided with conical or diamond-shaped projections or teats at both sides.

1161. "A new or improved lining for the walls of electric furnaces." W. P. THOMPSON. (Communicated from abroad by E. H. Cowles and A. H. Cowles, both of America.) Dated January 26. 6d. Relates to the apparatus described in the No. of the REVIEW for February 26th, 1886.

1310. "Improvement in telephone transmitters." W. P. THOMPSON. (Communicated from abroad by E. T. Gilliland, of America.) Dated January 29. 8d. Relates particularly to the form and construction of the containing chamber for carbon granulations; to the special form and relations of the electrodes; to the combination with the said electrodes of the said granular mass of low conducting material; and to the particular form of support or adjustable fixture devised for the transmitter proper; and, finally, to the form of air passage or speaking tube by which the sound waves are directed upon the diaphragm.

1354. "An improved electrode for secondary batteries." H. J. ALLISON. (Communicated from abroad by E. M. Gardner, of America.) Dated January 30. 6d. Consists in a new construction of the metal frame work or retaining plate, and in a new composition which is inserted in and supported by said plate. The composition consists of equal parts of pulverised carbon and lead oxide (red) intimately mixed. To three parts of this mixture is added one part of calcined magnesia. Dilute hydrochloric acid is then added in the proportion of one part acid to four parts water, and the resulting pasty mass is packed into cavities in the plate.

2403. "Improvements for operating electric smelting furnaces." H. J. HADDAN. (Communicated from abroad by E. H. Cowles and A. H. Cowles, both of America.) Dated February 18. 8d. This invention relates to improvements for operating electric smelting furnaces, in which an ampèremeter and resistance box are respectively connected in the circuit between the dynamo and the furnace, to the end that, by means of the ampèremeter, the strength of the current passing through the furnace is indicated, whereby is made known the resultant effect inside the furnace, so that the latter may be properly charged and the resistance increased or diminished to keep the strength of the current at a suitable medium, necessary alike for the reduction in the furnace and for the durability of the dynamo, the resistance box being used as an auxiliary governor in regulating the current. See REVIEW for February 26th, 1886.

CORRESPONDENCE.

The Tests at Messrs. Crompton's Works.

I think that all of us who are engaged in electric lighting will be interested in the tests which Messrs. Crompton have been good enough to publish; and I think, also, that many of us are indebted to you for calling our attention to the somewhat erratic nature of the tests.

The first point that strikes one, after a careful perusal of the figures, is how much farther advanced the infant branch of engineering is than its sisters. Though our instruments have an awkward trick of giving us different readings at different times, under the same conditions, more particularly if they have met with an accident in the meanwhile; yet there is no difficulty whatever in taking all the tests we require at any time, or in taking them continuously.

On the other hand, do you want to test the indicated H.P. your engine is furnishing, you become a perfect nuisance to everyone about. You require to exercise great skill and great care in making your tests, and in working them out. It is generally necessary to interfere with other work that may be going on, for fear that your tests may be upset. And, after all, what you have arrived at represents, in many cases, not the actual working conditions, but a special set of conditions that you have made for your test; and what is actually going on from day to day may be quite different to the results you have obtained.

Further, supposing that you are fortunate enough to obtain accurate results under actual working conditions, these may be altered even the next day by such a circumstance as is mentioned in the report, viz., that the boilers were not clean, or some part of the lubricating arrangements may not be doing its work properly.

One cannot help noticing, too, the striking irregularities in the speed; and I certainly agree with the remarks you have made that arrangements could have been made by lessening the load, if necessary, to keep the speed more constant; and that if this had been done the tests would have been far more valuable.

I hardly think, either, that the fact of the boiler not being up to its work is sufficient to account for the striking irregularities shown in the tables. As you have justly remarked, there is no load so easy to manage as an electrical one, under the conditions that ruled in this test. Practically, it might be taken as a constant load if the speed had remained constant; and in my experience I have always found that a heavy constant load was a very efficient governor.

A perusal of the figures will show, I think, that the variations of the exciting current were responsible for a good deal of the variation in the main current furnished. Presuming that the iron in the field-magnets and armature core was not saturated, an increase of the speed of the engine driving the excitor would lead immediately to an increased E.M.F. in the large dynamo and therefore to an increased demand upon the engine driving it, with the inevitable result that, if the steam did not follow, the speed would fall, and that is exactly what we find. We know, too, that a small engine, ungoverned, and with a light load, is very much more liable to variations of speed than a large engine working against a heavy load. I should therefore be strongly inclined to blame the government of the small exciting engine for the greater portion of the irregularities which are shown. Another point in connection with the exciting of the dynamo, which is probably due to an oversight, is that while the power used to excite the field-magnets has been carefully deducted from the output of the machine, no note has been taken of the I.H.P. consumed by the engine driving the excitor. Clearly this should have been added to the I.H.P. of the large engine, and the proportion that the measured output less what would have been used for exciting, bore to this total, would have been the measure of the efficiency of the system of engine and dynamo. Without this addition, the system is made to appear more efficient than it really is.

In fact, with this addition, the efficiency comes down to about 71·5 per cent.* This, however, considering that it includes the combined efficiency of engine and dynamo is remarkably good. It would have been exceedingly interesting to have known the efficiency of the engine by itself, which could have been easily done by indicating the engine running light and deducting the power absorbed from the power absorbed when running with the full load.

Now as to the question of the coal. I note that the report states that the quantity of water evaporated ought to have given a coal consumption of 2 lbs. per I.H.P., and of 2·7 lbs. per E.H.P. if the boiler had been good.

I fear that practical works managers would hardly accept this. They do not want to know what *ought* to be, but what *is* the consumption under actual working conditions; and, unfortunately, the figures come out at 6·37 lbs. of coal per indicated H.P., and 8·65 lbs. per electrical H.P. at terminals of the machine, taking the figures as they are given in Table VI., or rather over this, if the correction for power consumed by the engine driving the excitor be taken into account. These figures hardly bear out Mr. Crompton's statement in the discussion on Mr. Kapp's paper at the Institution of Civil Engineers, that Mr. Willans's engines were delivering work at a consumption of only 3½ lbs. of coal per net electrical H.P. Of course, allowance must be made for the state of Messrs. Crompton's boilers, but as we can hardly suppose that Messrs. Crompton's boilers were in a much worse condition than the generality of boilers that are used to generate steam for industrial purposes usually are, I can hardly help thinking that it would be wise, in calculating the

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cost of lighting, using these engines, to allow a pretty good margin for coming up.

As, too, 5 lbs. of coal per I.H.P. is the accepted standard for calculations, and is a standard that is supposed to err rather on the side of liberality in the quantity allowed, and this with ordinary engines that only use their steam once, while, with compound slow-speed engines, the consumption is very much less; it would appear, taking all things into consideration, that not much has been gained by the adoption of direct driving, even when in the hands of such competent men as Messrs. Willans and Crompton, and with all the assistance that the adoption of the compound principle gives.

The objections to high-speed engines, so far as I understand them, are threefold :—

First, they are usually more complicated; and if they do not present this disadvantage, they have some new arrangement which necessitates the employment of specially skilled labour should any little thing go wrong.

To those who, like the firm with which I am connected, have to not only supply those who would like to have electric light, but also to induce those who ought to want it, but are perhaps prejudiced against it, such a matter as that forms a serious consideration. It is one more point against us. Our friend perhaps knows nothing of dynamos, and if in addition we want to give him an engine that neither he nor any of his men understand, he will be likely to decline. He will await further developments.

The second objection to high speed engines is that, rightly or wrongly, they have the reputation of wearing out their working parts very quickly. Mr. Crompton related some rather discouraging experiences of his with one type of high speed engine in the discussion on Mr. Kapp's paper.

The third objection is that they use steam freely. This point the report says has been overcome in the Willans engine, only unfortunately the coal doesn't come out very well; and it is hard to dissociate one part from another. In most cases, water is cheap compared with coal. A manager would probably tell you that he didn't care a rush about the water consumption, what he would want to know would be what the coal was going to cost him; and it would not be of much use to tell him that if he had a different boiler he ought to get his power at 2 lbs. per I.H.P.; when at the trial at one of the leading works in the kingdom, one that is justly noted for its high-class work, the best that could be done was 6 lbs. odd per I.H.P.

One other point—what was the coal? A colliery manager showed me some the other day on his bank which he was glad to sell at sixpence per ton; while in the colliery districts generally, coal at 2s. 6d. a ton is generally used for firing. I presume, however, that at Chelmsford the cost would be very much in excess of this. The cheaper coal will, of course, not have the same heating power; but I think that to be of real service, the cost of an I.H.P. should be carried farther, and stated in terms of £ s. d., say in London, as it is obvious that work might be costing more in certain cases, although the consumption of coal might be less than in others, because one man was using a more expensive coal than the other, without getting a full return for the increased outlay.

Sydney F. Walker.

Cardiff, *May 4th*, 1886.

An Unexplored Field in Electric Lighting.

Your correspondent, Mr. Hamilton-Church, deserves the thanks of all electricians for the able and practical way in which he has discussed a question that has been indeed more than an open one—an untouched one, owing to the want of flexibility amongst English people in adapting themselves to circumstances. Because it has been hitherto impossible to obtain from Parliament the necessary powers to enable the formation of large lighting companies like the gas companies, English electricians appear to have tacitly agreed that electric lighting must be limited to individual large houses or large establishments, each taking a complete plant of its own.

I do wish some of our leading electrical lights, instead of driving ahead into the hidden mysteries of science, would devote their energies to studying the progress of electric lighting on the other side of the Atlantic, and adapting to English social life some of the clever contrivances and systems of the enterprising and successful Americans. To any Englishman acquainted with the boldness, ease and success with which the Americans put up and work electric light installations, the timorous, torpid manner in which our men here speak and think of the work is something deplorable.

As soon as a hundred houses get together in any part of the United States, down comes a contractor with an engine and dynamo and a gang of men; in a week wires are run everywhere, and the place is lighted up before an English firm would have got their estimate out; and the greatest secret of the American success is, that they are not afraid of the thing. They have reduced house lighting to as plain and practical a business as gas and water fitting, while we in England are still labouring under the impression that the electric light is a sort of "White Elephant"—very nice for those who can afford to lock up money in costly and complicated luxuries, but quite beyond the means of all who have not a national treasury at command, or something like it.

I want to see the electric light divested of the air of mystery that surrounds it in England.

If a builder wants 30 houses fitted up with gas, he does not begin by paying a troop of consulting engineers huge fees for drawing up idiotically complicated specifications for work that most ordinary working foremen can do by their own practical experience, and without any figures at all, but if he wants the electric light, Oh! that is quite a different thing, and cannot be approached without an amount of scientific palaver, and general expense and humbug, that would suffice to draw up a boundary line for a disputed territory.

Builders, as a class, are generally clever, enterprising men, and I do wish they could be brought to recognise that the amount of engineering skill required to fit up 30 houses with gas and water is amply sufficient to fit them up with the electric light. The electric light has passed the experimental process, and is as practical and matter of fact a business as the plumbing of a large mansion.

What I want and hope to see is the working electrical engineer forming as habitual a part of a good substantial builder's staff as the foreman carpenter or foreman mason, and that condition of things will come when builders recognise that such schemes as that of Mr. Hamilton-Church can be carried out by the builder himself from first to last, without any other technical aid than that of a working electrical engineer at about £2 a-week.

The builder can arrange for and construct his own engine house, he will know the number of lamps he means to have, one for each gas burner he would otherwise use, the makers will give him a lamp to give the same light as his ordinary gas burners, and will tell him the current and E.M.F. they want, and he can thus reckon for himself what ampères he must have, his electrician (if he be worth his salt) can tell him how much extra E.M.F. he must have to make up for loss through the cables, for the exact data are given in published tables that can be got through any scientific bookseller; he adds that to the E.M.F. of the lamps, adds on about one-fifth to both E.M.F. and current for margin (a thing which our highflown electrical engineers quite disdain, relying on the accuracy of their complicated calculations, and making some pretty messes in consequence), and writes to half-a-dozen of the principal electrical firms who make dynamos for prices for a machine to give that E.M.F. and current, and particulars of what horse-power and speed it will take. They will gladly supply this, and he chooses (if a wise man) a machine of middling price, neither the

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most costly nor the cheapest, and then applies to some good firm of engineers for an engine to give that speed and horse-power, letting them know that he does not want an affair with a score of recently patented alterations—by courtesy, improvements—but an old-fashioned, simple, strong steam engine. They will supply him with this; in a similar way he can get what wire and cables he wants, for which he or his electrician can calculate in their heads from the published tables, and the rest he can do himself.

He can put down his own engine and his own dynamo, the electrician can lay the cable and wire and fit the houses without any other help than the builder's own men, and the whole 30 houses and installation be done and finished thoroughly well at about one-half what an electric lighting firm would charge, *e.g.*, the builder can do it for about £2 to £3 a lamp, where an electric lighting firm would charge £5 to £7 ; or perhaps he can do it for still less, for the cost diminishes wonderfully when a large plant is employed, and things bought in quantities.

For the success of the work technically, the great thing is : eschew all calculations that cannot be made in the head or on the back of a postage stamp, and have the wiring done by a man who has had a good practical experience ; but not too much of it, not more than 10 years at the very outside ; men who have been longer in the business than this are generally (as I have found by sad experience) as old-fashioned as fossils, and quite as obstinate, doing things not because their judgment tells them they are necessary, but because they have been used to doing them for 20 years.

For the success of the work financially, if anything is costly, do without it, and get something that is not costly; and especially eschew all recent patents and patented articles ; do not be afraid of departing out of the beaten track, but copy the Yankee method ; if you cannot do a thing one way because of the cost, be sure there is some other way, cheaper and as good, and set to work to find it or make it.

Now for a few practical details. In such an installation as Mr. Hamilton-Church describes, I should most strongly suggest the use of accumulators, for this reason : the best of engines *may* break down ; the best of belts will break now and then ; and the steadiest of engine men will get drunk now and again ; and if the 30 houses are dependent for the light on the engine and dynamo keeping running, they will then be left in darkness suddenly, and there will be a row. If, however, accumulators are used, having storage power enough for one night's consumption, say, at most, eight hours in winter, falling to three or four in summer, they can be charged during the day, and at 5 o'clock the engine driver can lock up and go home, with the perfect certainty that the householders will have their light for that night at least all right, and, at a pinch, several hours the next day; so that if the engine should break down, there would always be time to repair it, or get a portable engine for the time. Moreover, the extra cost of these accumulators would not be very much, I think, because their use (enabling the employment of a much smaller and cheaper dynamo, and cheaper, simpler, and smaller engine, with the consequent saving of interest on cost price), would save a good deal of money in first outlay, and, as regards cost of cells, the builder could make these himself, just as he makes his doors and window frames.

His carpenters could make the cells, his plumbers the plates (pure lead), and, with the engine and dynamo required for the 30 houses, he could *form* his plates himself, at about one-third of the cost if bought. The old original Planté patent has expired long ago, and I believe I am right in saying (if not you, Sir, will correct me), that there is nothing legally to prevent any man making as many accumulators as he pleases by the old, but for excellence, unsurpassed process of forming the plates from the pure lead. The size of accumulators might be an element of inconvenience ; but 30 houses, at twenty 16 C.P. lamps each, could be lit for something like seven hours by 50 cells of 3 feet dimensions every way.

Space will not permit of my going further into questions of cost and detail ; but I may add two material points for the benefit of non-electrical readers :—

(1.) That these accumulators are simply reservoirs of electricity, just like the huge gasometers of a gas company, and are, to the full, as safe and steady ; and when once put up require very little more than just to be *let alone*.

(2.) That electrical fittings for a dwelling house are perfectly compatible with gas fittings ; the two could be put in together, so that if by any chance the electric light failed, or was discontinued, the gas would be always there, for ordinary gas fittings make capital supports for electric light wires and lamps, and save the cost of special fittings and chandeliers for the latter.

I must not trespass further on your valuable space, as I fear I have done too much already ; but if you considered it advisable to open your columns to information on the subject, I should be pleased to put together some practical instructions fôr a builder in Mr. Hamilton-Church's case.

I do not hesitate to say, speaking from a considerable practical experience, that it is quite possible for a builder of shrewdness and ability to be his own electrical engineer.

Edward Conry.

23, Villiers Street,
New Bushey, Herts, *May 3rd*, 1886.

Electricity v. Heat.

Thanks for your having published my three letters containing particulars of experiments which prove that electricity and heat are two independent elements.

There is another fact bearing on this subject which is of much practical importance to those who are interested in the passage of electricity through wires. The published writings of the late Mr. Sabine show that in 1883 he had discovered that when a wire was part coated with India-rubber, and part left bare, and on a current of electricity being passed through this wire the part coated with India-rubber was 25 per cent. cooler than the uncoated part in contact with the air. A Mr. White has recently made similar experiments in America, and it is alleged that he found that when a wire of 65 mils. was part coated with a covering of 285 mils., and a current of electricity passed through this wire the uncoated part became three times hotter than the coated part. Now every electrician will admit that a wire with a coating of 285 mils. of good insulating material should retain within it more perfectly the current of electricity than the other part of the same wire which was exposed to the air.

This being admitted, it becomes manifest that the source of the heat cannot be in the electricity, or else the coated part of the wire would have become the hottest part instead of being the coldest. The explanation of this is through the fact proved by my experiments that electricity has a powerful attraction for heat. The current of electricity while passing through the uncoated part of the wire had free access to the air, and in consequence the electricity within the wire attracted to itself the latent heat of the air, and thereby the wire became hot : whereas the part of the wire coated with the covering of 285 mils. remained cool, because the current of electricity while within that part of the wire was prevented from attracting to itself the heat of the surrounding air, because the covering was interposed. The practical conclusion to be drawn from this is that the covering for wires should be air-tight, and non-conducting of heat as well as being insulating.

This subject has an important bearing on the recent experiments so ably carried out by Prof. Hughes.

A copper wire consists of three things—*first*, molecules of copper ; *second*, latent heat ; *third*, latent electricity. These three things in the normal state of the wire are all balanced and in a state of rest to one

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another; but the moment an electrician forces a current of electricity into that wire the balanced state of the aforesaid three things is disturbed. When the forced current of electricity enters one end of the wire it attracts to itself a portion of the heat which had hitherto been at rest within the embrace of the normal electricity of the wire, and hence a new adjustment of the relative positions of the molecules of the copper, of the heat, and of the electricity takes place within the wire, beginning at the anode end and continuing to the cathode end of it. It is during this readjustment of the molecules of the foresaid three things that the wire is in that which has been called the variable state of it, and after the readjusted or new balanced condition of the three things has taken place the wire is then in that which is called the stable state.

James Johnstone.

8, Mercheston Park, Edinburgh,
May 3rd, 1886.

[Mr. Johnstone's explanation of the difference of temperature between the uncovered and covered portion of a wire through which a current is flowing is too absurd to be seriously entertained. If he will read a paper written by the late Robert Sabine, and published in our issue of January 6th, 1883, he will find therein the true explanation. Our correspondent has only sparingly favoured this journal with his fantastic theories, a matter of self-induction—we mean congratulation—and if he really desires to see his writings figure in our future issues they must at least be of a rational nature.—EDS. ELEC. REV.]

Electric Lighting on the Spey.

Perhaps a little further information with reference to the watt power for the above, mentioned in your notice last week, may prove interesting to some of your readers.

The arrangement in question was designed by me for the electricians Messrs. Craven and Elworthy.

The problem was to provide a simple and inexpensive, but efficient plant; to obtain the required power with a moderate fall. To meet these conditions a turbine was employed set open in a penstock. All toothed gearing was dispensed with and the power conveyed to the dynamo by belt. In this manner silent running was ensured. The arrangement is the best and most simple which can be employed for a low fall. There are, however, numerous instances where a high fall and limited quantity of water are more readily available. In such cases I prefer to lay a large water main for the triple purpose of water supply for domestic use, fire service, and as a conduit to a high pressure turbine for driving the electric machinery.

The turbine and dynamo may be fixed in any convenient outhouse and attended to by any "odd man" about the house. I would, however, add a word of warning. The size of pipe should be fixed by the maker of the turbine, with full knowledge of the height of fall, length of pipes and power required; otherwise they are liable to be laid too small. In fact, mistakes of this kind have even been made by makers of turbines whose experience has been but limited.

Charles L. Hett.

Brigg, *May 3rd*, 1886.

The Electric Light at Sea.

I have just read, in your current number, with pleasure the article on "The Night Passage of the Suez Canal," and would be very thankful if you or any of your contributors could give me in an early issue the *longest known* distances the electric light has been seen at sea on board ship or on land. A few "wrinkles" on either or both these points would be esteemed by

P. M. Purves.

Salford, *May 3rd*, 1886.

Electric Locomotion.

I read with great interest a note in your last issue respecting a trial trip of one of the Electric Locomotive and Power Company's engines, but was rather surprised to notice that all details of energy absorbed, rate of speed, &c., were omitted. However, I find these particulars noted in a weekly local paper, as follows:—

"A most important matter was the fact that the quantity (*sic*) of electrical energy used was considerably less than was expected, the running on the level road taking only 25 ampères and on the gradients from 40 to 65 ampères, and down hill no current whatever."

This represents a minimum rate of 4·6 E.H.P. on the level and a minimum of 12·1 E.H.P. upon the gradients.

Mr. Reckenzaun in his able articles upon electric locomotion in your valuable journal of February 26th, page 168, states most emphatically that a separate electric locomotive is a wasteful method of applying electrical power to tramway haulage. I have always considered Mr. Reckenzaun to be a recognised authority upon this subject, and am the more surprised to find that an apparatus which must necessarily weigh more than double the weight of the Reckenzaun motor and gearing should show a better result with much greater economy.

Another paragraph in the aforesaid local journal states that—

"Owing to the small amount of current used, no appreciable difference could be detected in the storage batteries, and at least seven or eight hours constant work could have been performed without any fall in their energy."

This is a plain proof, if correct, that the separate electric locomotive is the only successful method of applying electrical power for tramway propulsion. I am anxious to know how this marvel is accomplished, as I am deeply interested in the progress of electrical locomotion, and have hitherto believed that the motor fixed under the car itself was the best arrangement for the purpose, and in which I was confirmed by Mr. Reckenzaun's articles upon the subject.

Alfred Melhuish, *Mech. Engineer.*

Suggestions as to Testing Incandescent Lamps.

I have read Mr. Shippey's suggestions as published in your last week's issue relative to the above subject, which certainly open up a field for discussion, as some points suggested by him are novel.

There is, undoubtedly, a very great difference in the results obtained from one maker's lamps over another, even when marked the same voltage.

I have recently carried out a small installation with ½ H.P. Otto gas engine, driving one of Messrs. Greenwood and Batley's 750 watts dynamo machines, wound for 40 volts at 15 ampères; speed, 2,000 revolutions. I have tried several makers' 40 volts lamps, including the Swan, Woodhouse and Rawson, Gresham, and Shippey's; the latter lamp, I am bound to say, gives the best results. I was recommended by Messrs. Shippey Bros. to alter the pulley of the dynamo so as to run same at a slower speed, and use 30 volt lamps instead, which I did, and now run 14 lamps of 16 C.P. It is true, my lamps are somewhat overrun, but they stand it, and I get a more brilliant effect; I am satisfied with the result.

Messrs. Fuller and Son, of Finsbury, have a similar installation, using 30-volt lamps, but they use 16 accumulators, charged a few hours daily, which enables them to light over 30 lamps on two circuits for lighting their premises in the evening; these results are remarkable from a small ½ H.P. gas engine, and I know of nothing to equal this for small installations, and it clearly proves the advantages to be obtained in point of economy by using low resistance lamps for small domestic lighting installations over that of high E.M.F.

Frank Bilton.

May 4th, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 442.

SELF-REGULATING DYNAMOS.

THE recent discussion in a contemporary between the Reviewer of "Dynamo-Electric Machinery" and the Author of that work once more impresses us with the necessity for clear definition. The discussion had special reference to self-regulating dynamos and motors and arose out of a statement on the part of the Reviewer that no machine of which the magnetic field was partially supplied from an external source could have a critical speed. The Reviewer gave as his definition of critical speed that at which for a particular resistance in circuit the dynamo would just magnetise itself, while the Author declared that the correct meaning of critical speed was that at which the dynamo or motor became self-regulating.

Manifestly, as was pointed out at the close of the discussion, but one of these definitions can be right. Disregarding the arguments which were employed in a dispute which was not ours, it is our intention to make an independent investigation with a view to discover which definition is the correct one, and we shall probably be able also to see how the confusion has arisen.

In the paper read before the Society of Telegraph-Engineers by Profs. Ayrton and Perry on "Electro-Motors and their Government,"* the meaning which is intended to be conveyed by the term "critical speed" is clearly defined. They say, page 307, ... "*but even a slight increase in the speed of a dynamo, the circuit of which remains unaltered, will also produce the same effect if the speed be the critical speed for the resistance through which the dynamo is sending a current, because this critical speed is that below which but a small current is sent by the dynamo machine, and above which a great current is sent by the dynamo machine—that is to say, below the critical speed for any particular resistance the dynamo acts very feebly while above that speed it acts as a powerful dynamo machine.*" In a letter addressed to the *Electrician* in November of last year Prof. Ayrton remarked that their experiments had led them theoretically to the conclusion that for every speed of a dynamo, there is a *critical* value of the total resistance which, if exceeded, practically results in no current being generated : and in their paper on electro-motors they are careful to mention that the idea of a critical speed had been foreseen by Sir Wm. Thomson some years before it had occurred to them. In a paper read before the Institute of Mechanical Engineers in 1880,† Dr. J. Hopkinson had used the term *critical current* to express the particular current at which any given dynamo began to excite itself; and it was a study of the relation between the exciting speed and resistance which led M. Deprez to remark that by means of the characteristic we could see how there was a given resistance at which the excitement was nil and at which the machine ceased to act.*

Now, in the above utterances, there is no ambiguity of expression. The meaning of critical speed is quite clear, and the term had a distinct signification perfectly understood by electricians before self-regulating dynamos were at work in this country. As judged by their writings, there was obviously in the minds of the scientists quoted but one idea of critical speed, and expression was given to that idea in the statement that the critical speed was that at which for a given resistance in circuit the machine would only just give a current or magnetise itself.

Denoting current by abscissæ and E.M.F. by ordinates; if a straight line be drawn from O such that the tangent of the angle it makes with the axis of abscissæ represents the total resistance in circuit, the speed is critical when the line so drawn coincides with the straight part of the characteristic. A machine under such circumstances is extremely unstable, for if the resistance is but increased by a small amount no current will flow, while if it is diminished slightly the current will be excessive. Running under these conditions the speed is said to be critical for this resistance in circuit, also for this speed the resistance is said to be critical, and lastly there is a critical current for all speeds below which the machine will not work.

The statement so often made that the constant potential dynamo regulates at the critical speed for the combined resistance of the armature and series coil is found in practice to be untrue, and such a conception can only be due to a misunderstanding of the conditions on which in this class of machine regulation depends. Although no machines have been designed in which the mass of iron is so excessive as to cause the characteristic to be approximately a straight line for the whole of the excitement supplied by the two coils on the magnets, yet most of the mathematical work done in connection with regulating dynamos has been based on the assumption of a rectilinear characteristic.

Our readers will remember that the constant potential machine of Deprez had two coils wound on its fields, one separately excited by an auxiliary dynamo and the other in sèries with the armature and external part of the circuit. Let us keep this machine in mind, losing sight for a time of the wholly self-exciting compound machine with its shunt and series coils now so familiar to us. Here is the argument of Deprez, of Ayrton and Perry and of Thompson. We have a series dynamo with a large quantity of iron in it. We short circuit the machine and run it at a speed such that it just excites itself. This is the critical speed. An auxiliary coil is wound on the magnets, and this coil is separately excited while the machine is run

* Journal of the Society of Telegraph-Engineers and Electricians, No. 49, Vol. XII., 1883.

† Proceedings, 1880, page 266.

* "Electrical Transmission and Distribution of Energy," by M Deprez, ELECTRICAL REVIEW, March 22nd, 1884.

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at the speed previously determined. The machine, say these writers, will now regulate, giving a constant difference of potential at the terminals, which may be increased or diminished by increasing or diminishing the excitement furnished by the auxiliary coils. Such a machine, partly excited by a separate dynamo, has obviously no critical speed to correspond with our definition, since it will give a current at any speed and with any resistance in circuit. It is true that in this hypothetical machine, where we have assumed the characteristic to be rectilinear, the speed at which the machine regulates is *coincident* with the critical speed, but this cannot possibly justify the statement that critical speed is the same thing as regulating speed, and the coincidence in this case depends entirely upon the assumption above made, for in practice no such agreement is to be found between the two speeds. Because a particular machine happens to regulate at a velocity which is critical for the resistance of the armature and series coil, it does not follow that the correct definition of critical velocity is that at which any machine will regulate. The terms critical speed and regulating speed convey ideas essentially different, about which no confusion need exist, and only dynamos which are wholly self-exciting can have a critical speed.

So much for the hypothesis of the rectilinear characteristic, but let us examine the evidence of practice on this point. In the second edition of "Dynamo-Electric Machinery," page 97, with reference to machines constructed as described, we read: "*M. Deprez has further shown that this velocity can be deduced from experiment and that when the critical velocity has once been determined the machine can be adjusted to work at any desired E.M.F. by varying the strength of the separately excited current to the desired degree.*" Now this conclusion is based not only on the fact that we work on a portion of the characteristic which near the origin is approximately straight, but that this portion can be prolonged to excessive limits so that the E.M.F. added to the circuit by the series wire is independent of the amount of excitement furnished by the auxiliary coil. In practice this is never the case, and we question if a machine could be built which, fulfilling this condition, would regulate at its critical speed; at any rate, it is uniformly found that the regulating speed of a machine constructed in accordance with Deprez's views is always greater than the critical speed for the resistance of the armature and series coil, because of the impoverished effect of the series wire due to partial saturation by the auxiliary coil. As a consequence of this when the excitement is increased so as to produce a higher E.M.F. the speed must be increased in some definite relation to the separate excitation. In confirmation of this fact, it has been shown that the compound dynamo regulates with different potentials at very different speeds, the increased speed compensating for the diminished magnetism furnished by the series wire when the initial magnetism supplied by the shunt is high.

In investigating the action of regulating machines the effect of the series wire being modified as the initial magnetism undergoes changes seems to have been lost sight of. In the paper of Ayrton and Perry before referred to this consideration is clearly omitted, for in specifying the conditions of governing in motors they "*conclude that the resistance of the armature and demagnetising coil combined is such that it is the critical resistance of the dynamo part of the combination for the speed at which it is desired the motor shall always run, no matter what amount of work it may be doing.*" In other words the meaning is, that the velocity of the motor when working as a dynamo with the shunt coil inactive, which is just sufficient to send a current through itself, is the velocity at which it will regulate with the shunt coil in action. Without saying whether motors constructed on this plan will or will not be efficient, we think the omission referred to detracts seriously from the value of the general reasoning, since their constant potential compound motor excited by a shunt coil can have no critical speed, and a variation in velocity cannot, therefore, cause the dynamo part to act as a strong or weak brake above or below a fixed speed. As far as we can make out considerations regarding the relation between the magnetising powers of the two coils have been neglected in Deprez's work, and Thompson in his "Dynamo-Electric Machinery," excludes them in the mathematical treatment. This oversight is the cause of any confusion which may have arisen. The value of the series wire in adding to the E.M.F. of the machine has been supposed by these writers to be independent of the magnetism provided by the auxiliary coils. Knowing that, on the assumption of a rectilinear characteristic, the speed of regulation was coincident with the critical speed it was easy to imagine them synonymous terms. To call the regulating speed the critical speed when no relation existed between them was but the one step farther necessary to make the confusion complete.

In accordance with our definition, in a compound dynamo which is completely self-exciting and which has a shunt coil taking the place of Deprez's auxiliary coil, the speed, when the external circuit is open, is critical when it is just sufficient to cause the shunt coil to excite the machine. There is in the compound dynamo no one particular speed at which the machine will be self-regulating, since at several different speeds, although with different potentials, the machine regulates equally well for the whole range of its current. While in the past the notion that the speed of regulation must always be of equal value to the critical speed may have palliated the confusion of terms, now that the action of these machines is more fully understood, it would, we think, be wise to expunge any misconceptions which can be traced to our former ignorance.

HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

V.—SERIES MACHINES.—(*Continued.*)

HAVING found, as described, that the cores are not too large or too small, and having found the proper value of the diameter of the wire from the allowable fall of potential and the ampère turns, and also having guarded against heating, there remains only to provide that the last layer may be wound full, for the sake of appearance. This may be done in the case in which there are only a few turns more or less than what would be required to make it full, by simply winding it full and varying the speed slightly to compensate for this, if necessary. If, however, this difference is comparatively great, it is best to proceed as follows:—Calculate the number of turns which would come on the last incomplete layer, wind that number of turns on the next to the last layer, fill up the remaining space with cardboard, or the like, to the thickness of one layer, and wind the last layer full over all. Or it may be done by winding the odd number of turns in a coarse or open spiral in the next to the last layer, and then cover this with a sheet of stiff cardboard, over which wind the last layer full. This, however, is not as good as the first method, as the cardboard, if not very stiff, is apt to cave in.

Having made all the necessary calculations for the diameter of the wire, it is best to check the result by determining the loss of potential for the wire selected, and to compare this with the allowable loss of potential. To do this, calculate the corrected mean length of one winding l_m, in inches. The resistance will then be:

$$\text{R} = \frac{50{\cdot}13\ \text{W}\ l_m\ \theta}{d^2},$$

then from Ohm's law and this equation, the fall of potential in the whole magnet circuit will be:

$$v = \frac{50{\cdot}13\ (a\ \text{W})\ l_m\ \theta}{d^2},$$

which for $\theta = 0.0162$ and a temperature of 70° Fahr. becomes:

$$v = \frac{\cdot 875\,(a\,\text{W})\,l_m}{d^2} = \frac{3\cdot 5\,(a\,\text{W})\,l_m}{4\,d^2},$$

in which d is in mils and l_m is the corrected mean length in inches, of one winding.

If this gives a value much higher than that which was allowed, owing to the fact that the smaller gauge number wire nearest to the theoretical value obtained by the formula was taken, then if the difference is too great to be allowed, the next size larger may be taken, without necessitating any other change in dimensions.

If, when the machine is completed and is run on its proper circuit, it is desired to make the final accurate adjustment, it is only necessary to increase or diminish the speed by a few turns. This may be calculated from the final test by taking the speed proportional to the potential, provided the current strength was correct. If both the current and potential are slightly incorrect, alter the external resistance until the current is correct, then measure the potential and proceed as before. Care should be taken that the machine is warm throughout before making the measurements. These final adjustments will, if the machine is properly calculated, be very slight in most cases, and can, therefore, generally be dispensed with.

If it is desired to regulate the machine to supply the same current with different potentials, that is, to run a varying number of arc lamps, place the adjustable resistance in multiple arc (as a shunt) with the magnet coils. This will shunt off some of the current from the magnets, and will enable one to regulate the magnetism and therefore adjust for different numbers of lamps.

If this is to be done, make the first test for both the maximum and minimum number of lamps, noting the ampère windings required in both cases. Calculate and complete the machine just as before from the larger of these two numbers of ampère turns. The current required in the magnets in the two cases will evidently be proportional to the ampère windings, for the number of windings is the same. This gives the current required in the magnets when the smallest number of lamps are run. Having calculated the resistance of the coils, it is easy to calculate what the adjustable resistance should be in order that the proper amount of current may be shunted off by it, for the currents will be approximately inversely as the resistance.

If the normal current of the machine is a and the ampère turns required in the two extreme cases are $(a\ \text{W})$ and $(a'\ \text{W})$ then the current required in the magnets for the small load is approximately

$$a' = \frac{(a'\ \text{W})}{(a\ \text{W})}\,a,$$

and if R is the total resistance of the coils and r the minimum adjustable resistance for the small load, then

$$r = \frac{a'}{a - a}\,\text{R}.$$

The maximum adjustable resistance depends on whether the machine is to be regulated near its full load. If so, the maximum resistance can be calculated similarly to the above.

As the winding of the magnets is entirely independent of this resistance, a less troublesome and sufficiently accurate method of determining this resistance is to run the finished machine from its full load down to a short circuit, and, every time the load is reduced, adjusting any convenient resistance which shunts the magnets, so as to get the proper current in the external circuit. Measure these resistances for each case and calculate the adjustable resistance wire from this, taking care to proportion the diameter of the resistance wires so that they will not heat too much, and at the same time not require too much wire. The current going through the rheostat can be readily calculated for each case from the resistance of the magnets and the resistance of the shunt rheostat.

To illustrate the winding of a series machine according to the method described in this article, let us assume the following data:—

An arc light, series-wound machine is to be built for a 10 ampère current at 1,000 volts, or about 20—23 lamps. Speed, 1,200 revolutions.

The armature was constructed and a trial frame built. Upon running the machine with four temporary coils of 250 windings each, it was found to require an exciting current of 40 ampères to bring the current of the machine up to 10 ampères and 1,000 + 2·5 per cent. of 1,000 = 1,025 volts. This gives 250 × 4 × 40 = 40,000 = $(a\ \text{W})$ as a measure of the magnetism.

The oval cast iron cores were $8\frac{1}{2} \times 2\frac{3}{4}$ inches. The assumed thickness of coil is $\frac{1}{3}$ of $2\frac{3}{4}$, or about 1 inch. The periphery of core was found to be 18·8 inches. This gives from our formula* the mean length of one winding 22·1 inches. From the formula for the diameter of the wire for the magnets,

$$d = \sqrt{\frac{\cdot 875\,(a\,\text{W})\,l_m}{v}},$$

taking the allowable fall of potential at 25 volts, and assuming a factor of safety of 5 per cent., making v = 95 per cent. of 25 = 23·8 volts, the diameter will be

$$d = 181 \text{ mils}.$$

This is about No. 5 B and S. The heating will not be too great, for, from our constant for the density of current, a No. 9 wire will stand the current very well.

No. 5 wire was found to have an outside diameter of 220 mils. The length of core being 10 inches, there will be 45 windings per layer. As there must be 40,000 ampère windings, and being a series machine, and the current in the magnets being 10 ampères, there will be 4,000 windings, or 1,000 per magnet, or 22 layers, making a thickness of coil of $4\frac{3}{4}$ inches, as compared with our assumed thickness of 1 inch. This apparently absurd result shows that the magnets are very much too small, and that it would hardly be possible to finish the machine for such a large load. This might have been seen from the magnetic curve, but for the sake of illustration the calculations were also made.

The figures obtained will, however, not only show us what load this machine will carry, but will also enable us to calculate about what the size of the magnets should be for another machine which will give 1,000 volts.

To determine the first, let a, b, fig. 2 (see p. 412, May 7th), be the curve of magnetisation for this machine, obtained as described in the first part of these articles. It will be seen from this curve that the magnets are saturated at about 18,000 ampère turns, and unless it is intended to over-saturate the cores to obtain greater steadiness in the current, this will be the maximum magnetism which ought to be used. Dropping perpendiculars from b and d, the distance, o, e, will represent 1,025 volts, and o, f, the greatest number of volts which the machine will give if not over-saturated, provided that the required number of ampère windings will not make the coils too large. This distance, o, f, measured by the same scale, was found to be about 880 volts.

Calculating the diameter, d, again for 18,000 ampère turns, and an allowable loss of potential of 2·5 per cent. gives

$$d = 128\cdot 4 \text{ mils}.$$

This is almost exactly No. 8 B. and S. This will be found to be large enough not to heat too much. Its external diameter is about 158 mils. This gives 63 windings per layer, and about 7 layers, making a thickness of coil of 1·1 inches. This is about the assumed thickness of 1 inch, and shows that the machine is properly proportioned.

To check the result, calculate the fall of potential with a No. 8 wire and a thickness of 1·1 inch. This gives from our formula

* See ELECTRICAL REVIEW, March 19th.

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$$v = \frac{\cdot 875\ (a\ \text{w})\ l_m}{d^2} = 21\cdot 3 \text{ volts.}$$

This is inside of the limit of 22 volts, showing the calculations to be correct.

It is evident that another armature with more turns of wire might be used with the same frame, thus obtaining a higher potential with the same magnetisation, or the same potential with less magnetisation. This depends upon the nature of the armature used in the test, and belongs to the subject of armatures; it cannot therefore be discussed here. In this article it is assumed that the armature has been determined.

Let us now determine from the above test about what the size of the magnets should be for a new machine with the same armature, but giving the full potential of 1,025 volts, which is what it was originally intended for.

From the point, *d*, fig. 2, and from the size of the core, we can determine the saturation coefficient, or the allowable density of magnetisation for this particular quality of iron. As there are necessary for saturation 18,000 ampère turns, and as there are four magnets, if we divide one-fourth of this by the number of square inches in the cross-section of the core, viz., 18., it will give the allowable density or saturation coefficient. This gives 250 ampère windings per square inch. The cross-section of the new magnets must therefore be such that the density of magnetisation, as determined from the new number of ampère turns, does not exceed 250 per square inch.

To determine the ampère turns of the new magnets, prolong the part of the curve, *a*, *d*, fig. 2, until it intersects the line *b*, *e*, at a point, *c*; then *c*, *e*, will represent the magnetism required for 1,025 volts with the old magnets, if they were not over-saturated, for *b*, *e*, represents the magnetism required for 1,025 volts with the old machine in which the magnets are over-saturated.

Now from the point, *c*, it is seen that the distance, *c*, *e*, represents about 22,650 ampère turns. *d*, *f*, the allowable magnetisation for the small cores, is 18,000. Calling this (a w″) and *c*, *e*, the former (a w′), while the required number of ampère windings is represented by (a w), then, from the formula, the value of (a w) is

$$a\,\text{w} = \sqrt[3]{(a\ \text{w}')^2\ (a\ \text{w}'')} - 21{,}000.$$

This makes the new cross-section

$$\frac{21{,}000}{4 \times 250} = 21 \text{ square inches.}$$

The dimensions of the oval cores are, therefore, about 3 × 9 inches. The diameter of the wire will be, assuming a thickness of coil of about 1 inch,

$$d = 134 \text{ mils,}$$

or about No. 8 B. and S. This will not heat too much, as it is larger than that given by the allowable density of current. No. 8 wire has an outside diameter of about 158 mils., therefore, there will be 7 layers for a thickness of about 1 inch. This gives

$$\frac{21{,}000}{4 \times 7} = 75 \text{ turns per layer,}$$

making the new cores 75 × ·158 = 12 inches long.

To check the result, calculate the fall of potential from the formula, which gives

$$v = 26 \text{ volts,}$$

or only a trifle higher than what was assumed at the outset. This results from having chosen the next smaller size wire to that given by the formula.

Suppose the finished machine gave only 990 volts and 10 ampères, then the speed should be increased to

$$\frac{1{,}200 \times 1{,}000}{990} = 1{,}212 \text{ revolutions.}$$

In conclusion it may be necessary to state that the above figures are not taken from an actual case, as no such machine was at the disposal of the writer at the time. They are merely to illustrate the method, and are not to be taken as sizes to build a machine by, though at the same time they are not far from those of actual machines.

SELF-INDUCTION.

IN any attempt at determining by experiment the amount of self-induction in a linear conductor in which an electric current is started, we can only do so by measuring the retardation which the current experiences. The gradual development of the current up to its full strength as depending upon a longer or shorter period of time is, as is well known, illustrated by a curve, similar to the last figure, in which *o*, *i*, represents the ordinate of the *full*, or as Prof. Hughes terms it, the stable current, and 01 . 02 . 03 . . . . . 0*y* the divisions of time (in hundredths, or any other convenient part of a second), which is allowed for the growth of the current.

By so varying our experiment that we allow the current a definitely longer or shorter time for its development before we either interrupt or reverse it, and setting off the strengths of current obtained on the respective time ordinates, we obtain the curve which illustrates the growth or development of the *initial* or, as Prof. Hughes terms it, variable current. It appears to me evident, therefore, that for the purpose of determining the relative values of self-induction in two different wires we must insure in both cases an equal number of interruptions or reversals to make the comparative results between the two wires reliable; we must give in each case the current equal times for its development. I must confess that I fail to understand how far Prof. Hughes insures a predetermined regularity in his interruptor.

Now, with regard to measuring the retardation in a primary current by means of the increased resistance, it seems to me most desirable, if not absolutely necessary for the purpose of getting definite and not merely comparative results, that *the interruptions or reversals in the wire or conductor under experiment should not extend to any other part of the circuit.* Your readers will remember that, when measuring the full (or stable) current Prof. Hughes employed the interruptor in the telephone wire to adjust the bridge; but when ascertaining the self-induction in the wire under experiment he put the interruptor in the main circuit, and so produced self-induction not only in the wire, *x*, but in every part of the circuit; and I question whether even the E.M.F. of the battery was not influenced by it. I cannot help thinking but what the results were more or less of a comparative nature; it was balancing the self-induction of *x* against not only the resistance but also against the self-induction of the German silver wire of the bridge. For the purpose of ascertaining the retardation or self-induction in terms of resistance, the interruptions should take place in *x* alone, and they should be of a predetermined time value. Of course the interruptions required in the telephone bridge wire are here not referred to.

I here beg to suggest for your readers' approbation a form and construction of apparatus which I believe will fulfil the conditions asked for. The chief requirements of such an apparatus are: an interruptor or reverser, which should be capable of being rotated at definite speeds by clockwork or other similar means, of which the number of interruptions or reversals per second can be definitely arranged; and since such interruptor introduces into the circuit a certain resistance it should revolve just the same whether the full (stable) or the initial (variable) current is measured.

In fig. 1, I show an arrangement for measuring the retardation (or self-induction) due to an *alternating* current in a long wire with the special object of using the same strength of current through a series of experiments—such as for example: ascertaining the self-

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induction in wires of different diameters but of the same material. The current from the battery, B, passes through the galvanometer, G, the resistance box, R, thence to b_1, through the conducting surfaces of the key, K, to a_1 through the wire, x (under experiment), to a, by way of the key to b, from which a wire leads to the brush or spring of the current reverser, C, and

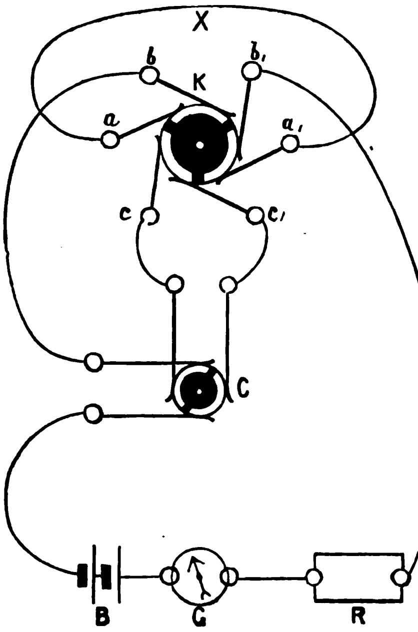

FIG. 1.

through this to c, then by way of the key to c_1, back to the reverser, and so returns to the battery, B. It will be evident that the reversals (changes or alternations) of the current produced by the reverser, C, will take place only in the short wires and brushes, or springs, c, c_1, whilst a steady full or stable current flows through the wire, x. Keeping the reverser at the same speed, and now turning the key, K, through 60°, into the position shown in fig. 2, the alternations will now take

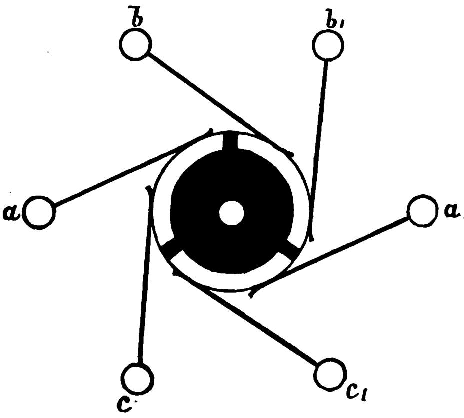

FIG. 2.

place in the wire, x. The increase of resistance due to self-induction in x will lessen the strength of the current, and so reduce the indications of G; but by reducing R we can bring the current to its previous strength. The changes in R together with the potentials between a and a_1, with a stable and a variable current, will give us the comparative resistance of x at the speed with which the reverser is rotated. Varying this latter and always working with the same strength of current we can map out our curve.

For the purpose of *interrupting* the current in the wire, x, alone, and yet keeping a steady current in the rest of the circuit, I would suggest the following arrangement: instead of one, I would take two lengths of the same wire under investigation, and join these two lengths in a manner and by an interruptor as shown in figs. 3 and 4, in which the current from the battery, B, passes through the galvanometer, G, and a conducting wire to h, where the two experimental wires, x_1, x_2, are joined; the other ends of them being brought into contact with a current reverser, C, by means of the brushes, b and c. From C the current is

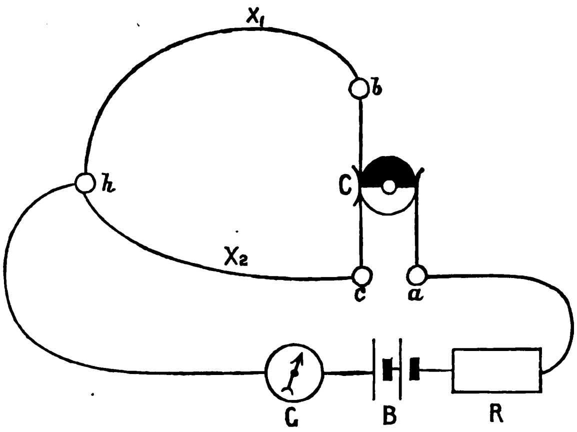

FIG. 3.

conducted by a third brush, a, through a wire to the rheostat, R, and thence back to the battery, B. The current reverser is constructed as shown in fig. 4, from which it is evident that with each revolution, through one half of it the spring, b, and through the other half the spring, c, is brought in circuit with the spring, a; and that whilst c is in circuit, b, by means of insulating material, is cut out and *vice versâ*. By the revolution of this reverser we send the current alternately through x_1 and x_2 always in the same direction, whilst

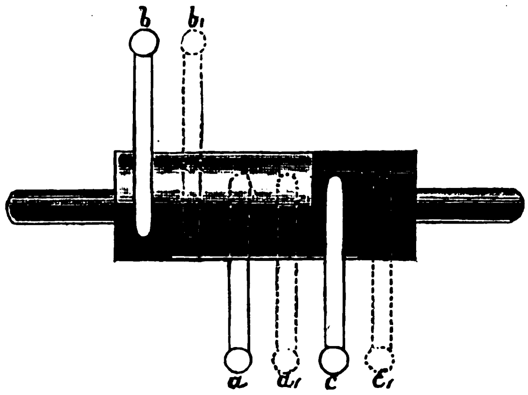

FIG. 4.

keeping up a continuous current in the rest of the circuit. The effect of sending a current in the same direction alternately through the two wires will be equivalent to interrupting a continuous current in one and the same wire.

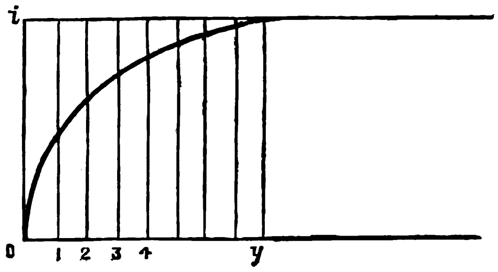

FIG. 5.

To measure the stable current in either one of the two wires the reverser or interruptor, as shown in fig. 4, is shifted along its axis, whereby the springs, a, b and c, come into a position in relation to the reverser as indicated by the dotted outlines, a_1, b_1, c_1, in

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which position, c_1, is cut out of circuit, whereas a_1 and b_1 remain in contact, at whatever speed the reverser or interruptor may revolve. The measurements here also are made by adjusting R to get constant indications in G; and the potentials between a and h can be ascertained.

This latter arrangement admits of being used in the Wheatstone bridge by making the two wires, x_1 and x_2, and the reverser C, that is, the part, a, h, to form the unknown arm in the bridge. So used, the resistance of x with a *variable current* could be balanced against a *stable current* in the remaining arms of the bridge.

I can but regret that multifarious harrassing engagements have prevented me from giving the subject the time and attention it deserves; and I must beg your readers to bear with me for the many shortcomings and imperfections, which are only too conspicuous in both communications.

C. GODFREY GÜMPEL.

Carlton, Burstow, Surrey.

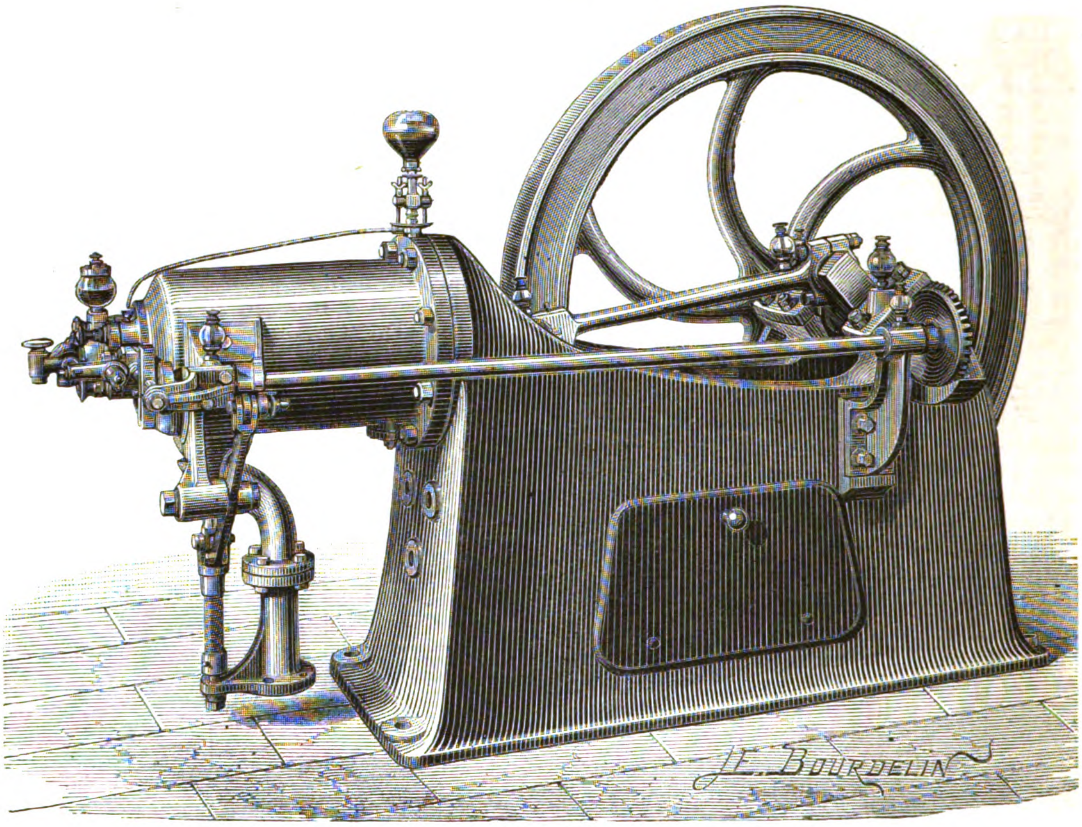

FIG. 1.

"LE SIMPLEX" GAS ENGINE.

A GAS engine, constructed by M. Thomas Powell, of Rouen, France, and which has been named "Le Simplex," has lately been prominently brought before the French public by a very satisfactory test made on it by Dr. Witz, of Lille, a professor well known by his several original experiments and publications on the behaviour of gas explosions in cylinders, &c.

The results of this trial are given in the table we publish, taken from the official report, and it will be seen that the engine is not only an exceedingly economical one in its consumption of gas per horse-power, but very regular in its speed. These, and the details of the engine, we think of sufficient interest to bring before the notice of our readers.

The engine is single acting, of the compression type, with an explosion at every second revolution, a type invented, we understand, by a French engineer, Beau de Rochas, but known in England in connection with the Otto engine.

From the illustrations the engine appears to bear out its right to its name.

The mode of ignition and the air pump governor are its two chief peculiarities. The ignition is by an electric spark, and the difficulties which have previously been experienced in electric ignition have been successfully overcome by the inventors, Messrs. Delaware and Malandin.

There are several advantages claimed for this electric ignition; poorer gases and mixtures can be fired, a greater number of ignitions in a given time can be assured and so a quicker running engine employed; the slide valve is comparatively cool, and the constant cleaning in the gas flame ignition from deposited carbon due to the heat of the slide valve is unnecessary.

The governor we show on an enlarged scale in fig. 2. It is simple and ingenious, and not only controls perfectly the speed of the engine, but permits the number of revolutions per minute up to the maximum of the engine to be varied by opening or closing the cone, R, by the screw, S.

The slide valve, A, is shown at its extreme outward position, and the spark, b, is shown in communication with the cylinder port, H. The passage, B, in the slide valve, comes opposite G and H to admit gas and air; but just before this takes place the gas valve is opened by the knife edge, Q, coming into contact with the gas valve spindle, U. The governor, T, being connected to the slide valve, moves with it, and as T moves forward, the plunger M, attached to the slide valve cover, being stationary, compresses the air in T. The amount of opening given by the cone, R, regulates the speed at which this air escapes; should the engine increase its speed in the slightest, this air, unable to escape at an increased rate, presses outwards the side piston, O, and the knife edge, Q, misses the gas valve spindle and no gas is admitted.

The engine was tried by Dr. Witz with ordinary lighting gas and Dowson's gas, with both of which it worked equally well; with the poorer gas the compression chamber was reduced by adding a packing piece to the piston, the compression chamber for the ordinary lighting gas being 32·4 per cent., and for Dowson's gas 25·6 per cent. of the cylinder volume.

The report, which we have not the space to publish in full, gives all the details of the trial.

Dr. Witz states that the indicated horse-power is too low, the difficulty in obtaining the true indicated

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power being due to the inertia of the spring and moving parts, &c., at such speeds and pressures. We expect to hear more of this engine, which appears very suitable for dynamo driving.

Dowson's gas, as most of our readers are aware, is a cheap gas made direct from anthracite coal, its power being about one-quarter that of ordinary coal gas.

The heating power of the ordinary gas used was 5,400 calories per cubic metre. Diameter of cylinder 7⅞ inches, and 15¾ inches stroke.

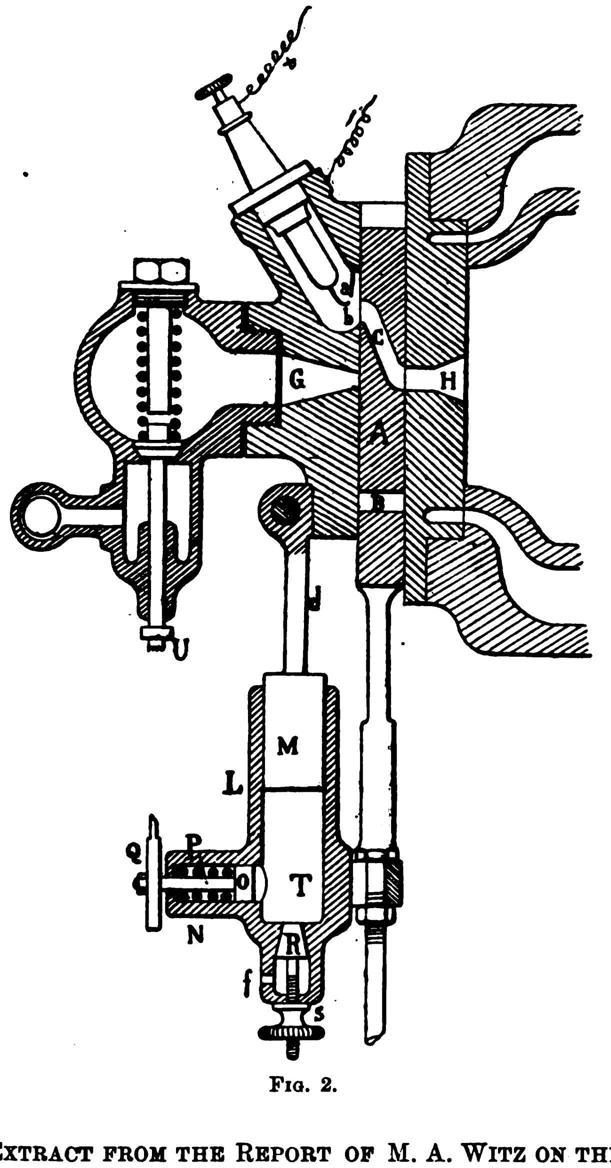

FIG. 2.

EXTRACT FROM THE REPORT OF M. A. WITZ ON THE CONSUMPTION IN THE ENGINE.

Duration of the experiment.	Revolutions per minute.	Effective work.	Water per effective H.P.	Gas per effective H.P.
EXPERIMENT ON NOVEMBER 7TH WITH TOWN GAS (*Engine* 8 *H.P. nominal*).				
2 hours	161·2	8·79 H.P.	19·9 litres	577 litres
1 hour.........	157·4	9·41 „	19·6 „	593 „
EXPERIMENT ON NOVEMBER 8TH WITH DOWSON GAS (*Engine* 6 *H.P. nominal*).				
2 hours	163·9	7·22 H.P.	26·1 litres	2,518 litres
½ hour.........	159·1	5·33 „	...	2,813 „

Compression for ordinary gas, previous to explosion, 65 lbs. per square inch; maximum pressure after explosion, 312 lbs. per square inch; and with Dowson's gas 96 lbs. and 312 lbs. per square inch.

Piston speed 425 feet per minute. Two experiments, of half an hour each, were made to prove the efficiency of the governor. The power varied from 5·66 brake horse-power to 3·33 B.H.P., and the following is the average speeds taken from the counter every five minutes:—

Trial No. 6 ... 159·8, 159·6, 158·4, 159·8, 156·0, 158·6.
„ No. 7 ... 160·6, 159·2, 159·4, 159·4, 159·8, 156·2.

COMPRESSED AIR MOTORS FOR ELECTRIC LIGHTING.

THE working of the pneumatic clocks established in Paris demands a certain quantity of compressed air, the production of which, in the centre of the town, at the very point where the distribution took place, entailed several inconveniences.

M. Popp, the director of the Pneumatic Clock Company, was therefore compelled to establish works, for the production of compressed air, in the Rue Saint Fargeau, and to transport it to the Rue Sainte-Anne by means of a wrought iron conduit, 8 centimètres in diameter inside, laid down in the sewers, extending as far as the Place du Château d'Eau, through the streets Saint Fargeau, Ménilmontaut, Oberkampf, the Boulevard Richard-Lenoir, and the Rue de la Douane. From the Place du Château d'Eau the canalisation follows the large boulevards as far as the Place de l'Opéra, the Avenue de l'Opéra, ending at No. 7, Rue Sainte-Anne. It is thus possible to establish along the course of this canalisation branch tubes of compressed air directly available for starting motors working dynamo-electric machines.

The work per revolution and the expenditure of compressed air being practically constant for a given type, it is sufficient to adapt a register of revolutions to the axle of each motor, in order to ascertain the mechanical energy supplied to the consumer in a given time, and estimate his consumption of motive power. The actual average price is we believe, 70 centimes per H.P. hour, or about 1 centime per kilogrammetre-hour.

The accompanying figure, from *La Nature*, shows one of the installations of electric lighting made according to this system. The compressed air motor, the normal speed of which is 160 revolutions per minute, works a Gramme machine excited in derivation, turning at 1,400 revolutions per minute, and able to give 40 ampères and 100 volts at the terminals, representing 4,000 watts or 5·5 available electrical horse-power.

Incandescence lamps of Messrs. Woodhouse and Rawson are arranged two in series, and each take 48 volts and 0·9 ampères, with a luminous power of about 15 candles. The lamps are lighted in independent groups, by a commutator established on the ground floor, within reach of one of the cashiers of the café, to whom the working is entrusted. The slight variations of luminous intensity that might result are greatly lessened by a series of 48 accumulators mounted in derivation on the terminals of the machine.

The system of regulation adopted in this installation and other similar ones, does not, writes M. Hospitalier, seem to meet the special requirements of the installation. The regulator employed regulates the variations in speed of the machine, but from the principle of the system itself, it is when the machine is producing the least work that it allows of the greatest speed, whereas the contrary ought to be the case, the machine requiring to turn somewhat faster when all the lamps are lit than when only a few are in use.

The regulator should therefore act in this particular case, not only on the speed of the machine, in order to limit the variations, but also on the circuit of excitation, so as to increase the resistance of this circuit when the machine is going rather too fast, which means that it is only feeding a few lamps, and

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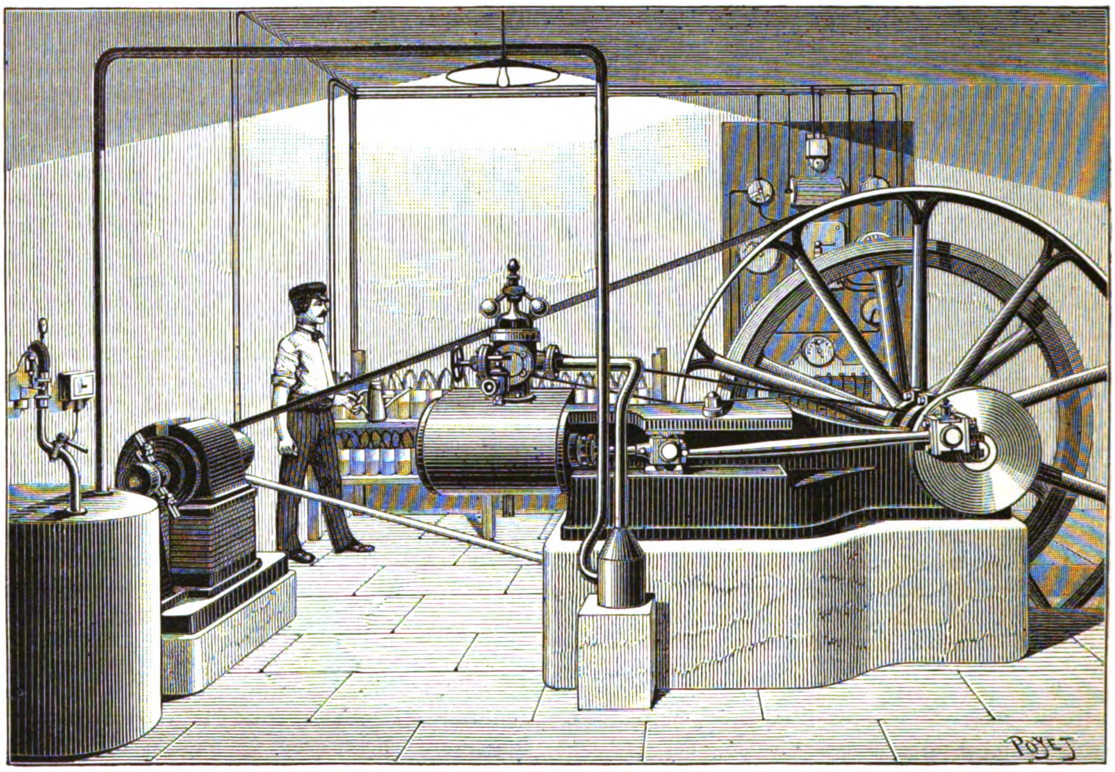
to diminish the resistance when it is turning more slowly. Or, we might employ an electrical governor maintaining constant, not the speed, but the difference of the potentials at the terminals of the machine. It is under these conditions that we shall arrive at a veritable distribution, and that the absolute independence of the lamps will be ensured.

Similar installations, both of arc and incandescent lamps, are established along the course of the canalisation, and others are in course of preparation; the demands exceed the total capabilities of the canalisation, and M. Popp is endeavouring to meet them by increasing the diameter of the pipes, and by effecting indirect lightings by means of accumulators charged during the day, when the direct lightings cease. This is the best proof of the success of this distribution of motive power but that should not lead us to believe that the distribution of motive force by compressed air is an advantageous method or one superior to other known systems. We must not, in fact, forget that the rendering of a distribution of compressed air is very low, less than 40 per cent., that it



Installation in the Basement of the Café de Paris.

diminishes very rapidly in proportion as the initial pressure is increased, that it only supplies motive power, and indirectly electrical energy after a second transformation, and a second installation, whereas a distribution of electrical energy would supply, directly, with a higher rendering and greater conveniences, either the necessary electrical energy for incandescence lamps, or the motive power required for other industries.

While acknowledging the advantages of the system, and admitting that we should certainly avail ourselves of it for the purposes of canalisation, we must still assert, that, in our opinion, the distribution of compressed air is simply a provisional solution, experimental and temporary only, and that in the future a distribution of electrical energy awaits us that will supply us directly and at will with light and motive power, from the central works, without our having to trouble ourselves in the matter.

On the Thames in an Electric Launch.—The turbaned Hindoo to whom we referred in our last week's article, turns out to have been no other than His Highness the Thakore of Gondal, Katyawar, India.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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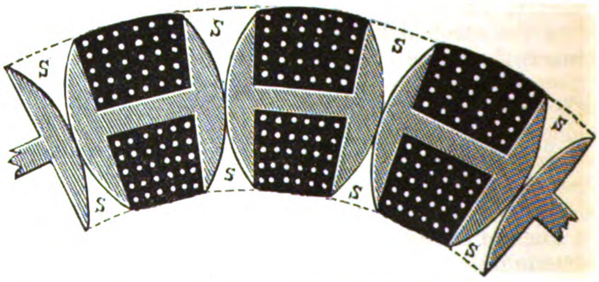
(*Continued from page* 423.)

I HAVE already explained the manner in which electric currents are produced in a coil of wire by the rapid insertion and withdrawal of a magnet; I need scarcely remind you that precisely similar effects would be produced if the magnet were made stationary and the coil left free to slide backwards and forwards upon it. The improvement introduced in the means of producing currents by Dr. Werner Siemens, whose armature was made to revolve in an intense magnetic field, with the effect of obtaining increased results and greater economy in construction, is also familiar to you, therefore no surprise need be manifested at what I shall now show you with my ring form of armature, as devised by Pacinotti.

Some persons of a hypercritical turn of mind might go so far as to say that a Pacinotti ring looks suspiciously as if made up of a number of Siemens armatures, placed round in a circle and end on, as partly



PORTION OF RING FORMED OF SIEMENS ARMATURES.

shown in this sketch. So it does; and, indeed, a ring formed in such a manner would act as a capital substitute for that of Pacinotti, the only difference being that in the former the projections or teeth have a space, *s*,

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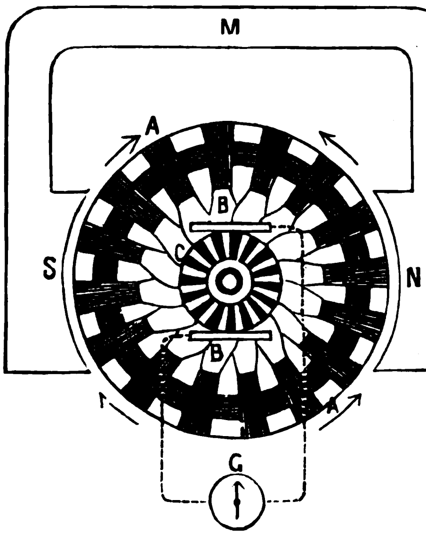
whilst in the latter the teeth are solid. Nevertheless, it must not be supposed that Pacinotti ever had the faintest notion of this; I make the suggestion in the light of a knowledge with which I was not endowed at that time.

Now, by the aid of another sketch, I will ask you to imagine a Pacinotti ring attached to an axle upon which it can rapidly rotate, and placed between the poles, N and S, of the magnet, M. I have before, by means of a previous diagram, shown the manner in which the coils of copper wire wound in the grooves



DIAGRAMMATIC REPRESENTATION OF PACINOTTI MACHINE, WITH PERMANENT MAGNET FIELD.

around the ring were connected together, so I need only mention here that C is the current collector, formed as previously explained; A, A, are the coils of wire, and B, B, are two collecting brushes or rubbers, from which the current produced may be taken. Now to speak of the action which ensues when the ring is set in rapid rotation.

From the remarks I have let fall concerning the Siemens armature, you can see that the magnetic effect which is set up between the N and S poles of the magnet, M, and the iron ring is very powerful, owing to the proximity of the teeth to these poles. We may say, then, that an intense magnetic field is thereby produced.

You think the meaning of "magnetic field" would be made more clear by further reference thereto? Very good; here is a simple example! If we bring a piece of iron near to the end of a magnet, it is assumed that invisible lines—"lines of force" as they are technically called—are set up, or pass, between the magnet and the iron. This assumption has been deduced from a simple experiment. If we place over our magnet, M, and its attendant piece of iron, I, a pane of glass, G, and sprinkle thereupon some fine iron filings, these latter distribute themselves in lines, somewhat in the following manner:—

Similar, but invisible lines are supposed to exist pervading the space between the magnet and the iron; these are the "lines of force," and when a wire is made to pass through these lines in a direction at right angles to them, it is said to pass through the magnetic field and cut the lines of force; the consequence of this is that a current is induced in the wires, or coils of wire, which come within the influence of the magnetic field.

A Pacinotti ring, therefore, revolving rapidly in the magnetic field produced between itself and the end of the magnet, M, must necessarily cause electric currents to circulate in all the coils surrounding it. These currents flow in the direction of the arrows, + or *positive* in one half of the ring, and − or *negative* in the other half. The brushes, B, B, rubbing on the collector enable us to take off continuously the currents produced, which are always in the same direction, as could be seen by the deflection of the galvanometer, G, so that at last we had here a source of electrical energy precisely similar in effect to that of a galvanic battery, only many times more powerful than the ordinary sized galvanic cells.

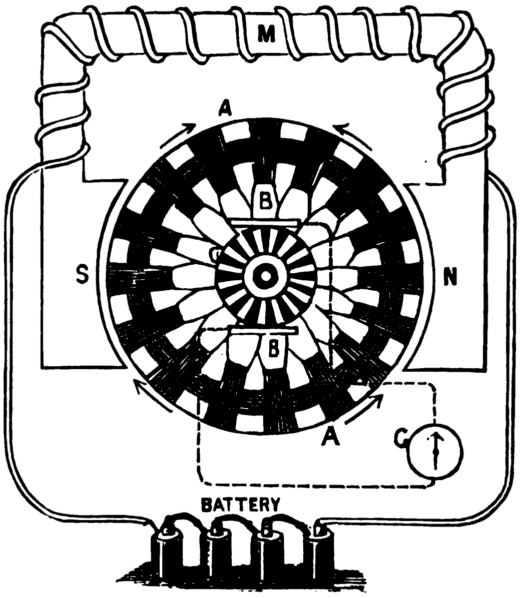
In referring some time since to the English electrician, Sturgeon, I spoke of the vastly greater power which an electro-magnet possesses over the permanent form. If, then, we substitute the one for the other, exciting the electro-magnet by a galvanic battery, we get a much more intense magnetic effect, and consequently more powerful currents from the ring, at the expense, of course, of extra labour in revolving it.

Pacinotti, indeed, employed the electro-magnet to produce the magnetic field, but I preferred to give you as a typical example of his invention the permanent magnet, as being more simple.

Yes; the diagrams, as you assume, are not quite in accordance with the original construction of the Pacinotti apparatus, but they explain precisely the principle upon which it was based.

You have a dim recollection of seeing something answering to my description in the Paris Exhibition of 1881? You are correct; I was there, and in the guise depicted in this illustration, having thus existed since the year 1860. Whether it was that Pacinotti failed to see the great future before me, or whether the time of day was not then sufficiently ripe to turn me to a satisfactory account, is a matter upon which I will leave you to ponder.

As you will notice, there are points in construction to which I have not alluded in explaining the principle; these, however, are details which do not form a theme of interest to the general reader, and as for yourself, well! with these you are familiar. Some time previous to 1860 a Dane, Soren Hjorth, patented an invention in which the principles I have just enumerated were fully explained. I have never been able to satisfy myself that he ever constructed his proposed apparatus, which would, however, have been of essentially different construction to that of Pacinotti. Indeed, at this time, so little public interest



DIAGRAMMATIC REPRESENTATION OF PACINOTTI MACHINE, WITH ELECTRO-MAGNETIC FIELD.

was manifested in inventions of the kind that I doubt whether Pacinotti's apparatus was known in this country 10 years ago, or if ever made public it had been forgotten. It is not a little interesting to know that the apparatus of the clever Italian was constructed by him to act not only as a generator of electrical energy but also as an electro-motor, the respective properties or duties of which I have mentioned. The reversibility of the Pacinotti machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric currents. Set them to drive a Pacinotti machine as an electro-motor, and let it, by

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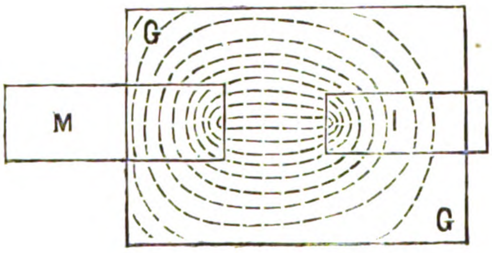
means of a pulley, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the machine, which in its turn will generate currents as it runs down.

Pacinotti one day, when describing me, said: "It seems to me that that which augments the value of this model is the facility which it offers of being able to transform an electro-magnetic machine into a *magneto-electric machine with continuous currents.* If, instead of the electro-magnet there were a permanent magnet, and if the ring were set turning, one would have made it into a magneto-electric machine, which would give a continuous induced current, directed always in the same sense."

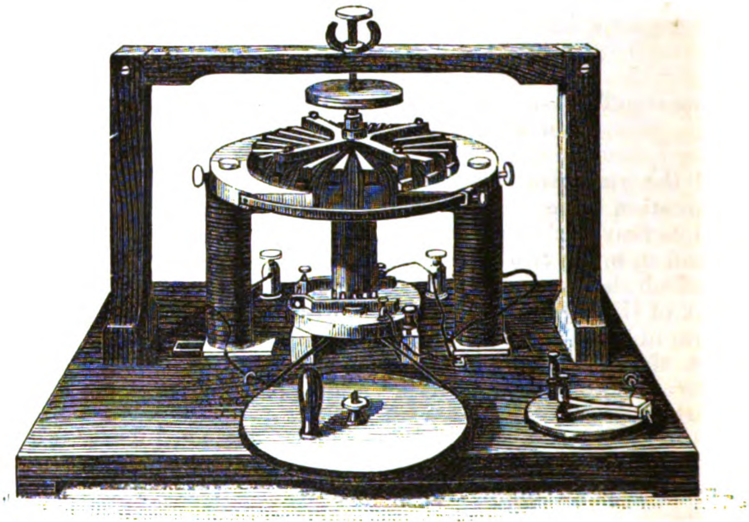
There was one drawback, however, attached to me in those days; to render me capable of generating electric currents, it was necessary to employ either a permanent magnet which produced a somewhat weak magnetic field, or an electro-magnet whose more intense magnetism was effected at the expense of a galvanic battery.

It was reserved for another of your countrymen, Mr. S. A. Varley, to whom I casually referred when speaking of Faraday's labours, to discover the self-exciting or mutual accumulation principle upon which *all* the dynamos by which you are surrounded act.

It is known that iron, which I have previously said does not retain magnetism in the manner of steel, still



A MAGNETIC FIELD.



THE ORIGINAL PACINOTTI ELECTRO-MAGNETIC OR MAGNETO-ELECTRIC MACHINE.

shows traces in a very slight degree after magnetisation, and to the uses to which the *residual* magnetism which exists in even soft iron was directed, we owe the rapid progress which has since been made in dynamo construction. In fact, here was the true dynamo-electric principle which enables a machine in itself to develop the greatest magnetism in its electro-magnets from the very feeble residual magnetism or initial energy residing in its iron cores, and which gave for the first time full importance to Pacinotti's invention. As both the late scientists, Sir Charles Wheatstone and Sir William Siemens, have hitherto received the credit of this most important discovery, it is naturally very important that I should show you conclusive proofs of the priority of Mr. Varley's claims, and to this task I cheerfully devote myself.

(*To be continued.*)

Nothing like Leather.—It is unofficially stated that since the removal of telephones in the city of Indianapolis the streets have taken on a much more business-like appearance. This is due to the fact that business men are compelled to run all over the city, spending half a day attending to business that was formerly completed in five minutes in their office, by use of the telephone. The shoe trade is looking up in Indiana.

ELECTRICITY ON BOARD THE "TAKACHIHO KAN."

THE magnificent cruiser, *Takachiho Kan*, built for the Imperial Japanese Navy by Messrs. Sir W. G. Armstrong, Mitchell & Co., left the Tyne on her voyage to Japan on the morning of the 6th inst.

This vessel, which is of 3,600 tons displacement and over 7,500 H.P. is, excepting only her sister ship the *Naniwa Kan*, now well on her homeward voyage, the fastest and most redoubtable cruiser at present afloat, her mean speed of 18·8 knots being second to none.

On each of these ships (the two are precisely similar in every detail), electricity is well to the fore.

The two 25 ton 10 inch and six 6 inch guns, are all fitted with electric firing gear, so that by pressing a key in the armoured conning tower on the forward bridge, a broadside of five guns can be simultaneously discharged. The correct aim is obtained by means of an instrument called a *director*, which is a species of fixed adjustable telescope, ten guns being so laid that if fired when a definite part of the target is visible through the director, the several shots will all strike the target at identically the same place, this being of great importance where armour is being dealt with.

The ship is also fitted with four tubes for discharging locomotive torpedoes, which are fired electrically from stations on the upper deck in a similar manner to the guns. Each tube has, however, its own director and firing key, and is independent of its neighbours.

As regards electric lighting, the two engine-rooms, the stokeholes, coal bunkers, magazines, captains' cabins and chart-house, are fitted throughout with 16 C.P. Swan incandescent lamps, 108 being the total number employed.

There are also four search lights, each of 25,000 C.P., two on each bridge.

The generating plant consists of four dynamos driven by two of Messrs. Goodfellow and Matthews's compound "triplex" engines. Two of the dynamos with their engine are in the forward part of the vessel, while the others are in the forward engine-room, all being below the water line, and under the 3 inch protective steel deck which covers all the vitals of the ship. A system of trunk wires between the switchboards at the two dynamo stations permits of any dynamo being connected to any of the four search lights or eight incandescent lamp circuits.

The whole of the electric light installation, including search and incandescent light circuits and trunk connections is wired on the double wire system according to a new and original plan worked out by Mr. A. A. Campbell-Swinton, electrician to Messrs. Sir W. G. Armstrong, Mitchell & Co., by means of which the customary unsightly and costly wood casing is entirely done away with, the wires, great and small,

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having a watertight lead skin which sufficiently protects the insulation without any further covering.

This arrangement, while presenting a particularly neat appearance, has proved very efficient and satisfactory in practice.

The entire lighting and other electrical installations have been carried out by the electrical department of Messrs. Sir W. G. Armstrong, Mitchell & Co., the builders of both vessels.

THE EDINBURGH EXHIBITION.

THIS Exhibition was opened on the 6th inst. by Prince Albert Victor with the usual pageantry and loyal demonstrations in the way of presentations and addresses.

Throughout the day direct telephonic communication with Glasgow was maintained from the National Telephone Company's stand in No. 19 Court. The arrival of the Prince in the Exhibition was immediately telephoned to Glasgow, as were also his subsequent movements till the close of the ceremony.

All the evening the building and grounds were crowded almost to inconvenience. Between seven and eight the waning daylight caused the electric light to be brought into requisition in the Exhibition. The central corridor was instantaneously lighted up with the incandescent lamps provided by Messrs. King, Brown & Co. The great hall and the side courts were also lighted up with the arc lights of the Brush Company, Gülcher & Co., Andrews & Co., and Mr. Miller, who provides the Thomson-Houston lamps. The lighting was entirely satisfactory both to the electricians and the public, the arc lamps burning with a perfectly pure and steady light.

The total number of visitors for the day, including season ticket holders, is estimated at upwards of 40,000.

The Gülcher Electric Light and Power Company, Limited, has favoured us with the following official account of its installation:—

Lighting of Section C.

This section is lighted by 32 3,000-candle-power Gülcher arc lamps, placed four in each court, and suspended by the company's improved raising and lowering counterbalance arrangement, the method of suspension dispensing with all slack unsightly cable, as the current for working the lamp is carried by the suspending cord, avoiding the inconvenience of pulleys and ropes. Each arc lamp is worked by an independent switch, so that any number of lamps may be used as desired.

Reception Rooms and Stalls.

The two reception rooms and many of the exhibitors' stalls are lighted by incandescent lamps suspended either by pendants or fittings as found most suitable, the current being taken from the dynamo as for the arc lamps, which clearly demonstrates the advantages of the Gülcher system for indoor illumination of public buildings or factories, as it enables a combination of arc and incandescent lamps to be driven from one dynamo.

Ground Illumination.

The grounds are lighted by 32 2,000-candle-power Gülcher arc lamps, constructed for outdoor work, fitted with clear glass globes and white reflectors, the lamps are suspended in groups of four arranged on high poles, each of which is fitted with a special head gear for carrying the lamps and to enable them to be raised and lowered as required, and each arc lamp (as at section C) is fitted with a switch.

Engines, Dynamos, &c.

Engines.—The installation is driven by a pair of 50 H.P. nominal horizontal high pressure engines by Messrs. Robey & Co., of Lincoln, specially constructed for driving electric light machinery, and fitted with special automatic cut off gear, which effectually regulates the speed of the engines.

Dynamos.—The current for working the 64 arc lamps and incandescent lamps is generated by four No. 5 compound wound Gülcher dynamo machines of the company's most improved type. Each dynamo is capable of giving a current of 300 ampères at an estimated total of 65 to 70 volts at the terminals with a speed of 500 revolutions per minute, and will drive either 20 3,000-candle-power arc lamps, 37 2,000-candle-power arc lamps, or 300 to 350 20-candle-power incandescent lamps.

If desired, a combination of arc and incandescent lamps may be run from the same machine.

The dynamo is very substantially constructed; the bearings are very long, and fitted with special oiling arrangements and oil catches. The armature is balanced, and in case of an accidental breaking off, any of its sections can be very easily repaired, and all parts are readily accessible.

The foreman electrician to Messrs. King, Brown and Co. writes to us on the subject of lighting the Exhibition to the following effect:—

"Allow me to correct your account of the 7th inst., regarding the lighting of the central corridor at the Edinburgh International Exhibition, which has a total of 75 girders, each one having 19 lamps, making a total of 1,425; there are two lavatories, each with 10 lamps, and a great many exhibits which are fed from the same circuits, which number over all 1,460.

"These circuits are so arranged that half may be turned out, still leaving every other girder alight; there are six sections, and six dynamos produce the current for the whole corridor; these are supplied by power from three vertical Marshall engines of 14 H.P. each, and there are also one vertical engine and two dynamos which are kept in reserve.

"The outside lighting is effected by 1,200 lamps of 10 C.P. each of 96 volts; these are a speciality in a 10 C.P. lamp, and are supplied by the Edison-Swan Company. For these are used, two horizontal Marshall 10 H.P. engines, driving two dynamos.

"You will see from this that there are only eight dynamos in actual work and five engines."

THE NEW ELECTRIC LIGHTING BILLS.

THE bills introduced by Lord Rayleigh, Viscount Bury, and Lord Houghton, with the object of amending the Electric Lighting Act passed by Mr. Chamberlain in 1882, have this week been under the consideration of a Select Committee of the House of Lords, consisting of Lord Camperdown (Chairman), and Lords Cowper, Balfour, Bury, Rayleigh, Houghton, Bramwell, Crawford, and Wolverton. We have, in these columns, explained at some length the provisions of these bills; and accordingly it is now necessary only briefly to recapitulate their leading features. Those interested in the progress of electric lighting are aware of the complaints as to the stringency of the provisions of the Act of 1882. The loudest outcry was against clause 27, which lays down the conditions under which the undertaking of a private company may be acquired, compulsorily, by the local authority. This provision authorises the compulsory purchase, by any local authority desiring to do so, of the undertaking of any electric lighting company supplying any part of the area within the jurisdiction of such local authority, at the termination of a period of 21 years. Not only does it thus render a company liable to have its business taken over at a time when it may only have begun to be profitable, but the clause goes on to enact that no allowance is to be made for the goodwill of the business thus taken over, or compensation for disturbance or loss of profits; but that the sole price to be paid shall be the then value of "all lands buildings, works, materials, and plant," suitable to the company's operations. Such an enactment is regarded as unjust to the Electric Lighting Companies, who may be only beginning to reap a return for the use of their capital when the enterprise in which it is invested may be taken from them by the local authority under this one-sided "power of purchase" clause. There are other features in the Act of 1882 to which the Companies take exception; but this clause is their peculiar *bête noire;* and the main object of all the three bills now before their Lordships' Committee is to amend this objectionable provision. Lord Rayleigh's bill, which was the first introduced, is a measure the clauses of which seek to give legislative effect to the views of the Electric Lighting Committee. It proposes to purge the Act of 1882 by the effectual method of the entire repeal of clause 27, and the substitution therefor of a provision similiar to that in the Public Health Act of 1875, sanctioning the acquisition of gas undertakings by "agreement," upon "any terms" that may be

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arranged between the Local Authorities and the Gas Companies. Other clauses of the sixteen of which this bill is composed seek further to assimilate the legislative conditions under which the business of supplying the electric light may be carried on to those which prevail in regard to gas companies. Section 4, 5, and 6 enact penalties for the fraudulent use of electricity, or wilful damage to works, lamps, &c. Section 7 proposes the repeal of so much of section 18 of the Act of 1882 as prohibits the Electric Lighting Companies from prescribing any special form of lamp or burner, or otherwise controlling or interfering with the manner in which electricity supplied by them under their Act is used. Sections 9 and 10 apply to capital and dividends, and in these respects proposes, as in the case of gas companies, that each Provisional Order, or Special Act, shall fix a standard dividend and a standard price for electricity. Then the gas sliding scale is brought into operation, and the dividend may be increased by a quarter per cent. for every reduction of a farthing in the price of the electrical unit; while any excess of profit over the amount necessary to pay the dividend is to go to form a reserve fund. When the creation of new capital is sanctioned, this bill provides that it shall be sold by public auction, or tender, at a reserve price not lower than its nominal value. Viscount Bury is responsible for the introduction of the second amending bill. It also proposes the repeal of the 27th clause of Mr. Chamberlain's Act, and the substitution therefor of provisions to the effect that where undertakers are authorised to supply electricity within any area, the local authority of that area may, after the termination of 41 years, and within six months after the expiration of every subsequent period of seven years, require the undertakers to sell to them their undertaking, "upon terms of paying the then value thereof as a going concern." Lord Bury's bill, moreover, would remove the prohibition resting upon the companies of prescribing any special form of lamp or burner for use by their customers; and it would also authorise the Board of Trade to grant licences to companies seeking to supply areas whose local authorities already hold a licence or provisional order for the supply of electricity, without the consent of those local authorities. Lord Houghton is in charge of the third bill which the Board of Trade, on behalf of the Government, has drafted. It proposes that the period within which compulsory acquisition by the local authority shall not be possible shall be specified in the Provisional Order or Special Act under which the Electric Lighting Company is carrying on its operations; that such period shall not exceed 42 years; that where no period is specified in the Order or Act, the period shall be deemed as one of 30 years; and that no period exceeding 30 years shall be specified, except with the consent of the local authority of the area within which the Order or Act would apply. As will be understood, the Gas Corporations and Companies view with little favour the proposed alterations, and they, as well as the friends of electricity, were well represented at the Committee on Monday. Many corporations have petitioned against the bills, including those of such important municipalities as Birmingham, Blackburn, Bolton, Burnley, Dundee, Edinburgh, Glasgow, Leeds, Liverpool, London, Manchester, Newcastle, Nottingham, and Paisley. The Committee conducted its deliberations and heard evidence in private, and we understand that on all who were admitted within the room the seal of secrecy as to what was said and done was imposed.

The witnesses examined included Mr. L. L. Cohen, M.P., Mr. Hucks Gibbs, Prof. George Forbes and Mr. Crompton. The committee adjourned at four o'clock, and resumed hearing evidence on Wednesday, when the proceedings were conducted with the same privacy as on the previous day.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

Monday, May 10th, 1886.

IN this action for infringement of incandescent lamp patents Sir Richard Webster, Q.C., Mr. Aston, Q.C., and Mr. Fletcher Moulton, Q.C., instructed by Messrs. Ashurst, Morris, Crisp and Co., were the counsel for the plaintiffs, and the Solicitor-General Sir Horace Davey, Q.C.), Mr. Charles, Q.C., and Mr. Macrory instructed by Mr. Sidney Morse, were counsel for the defendants.

Sir RICHARD WEBSTER, in opening the case, stated that the first action was upon three patents, and in the course of his opening in the first action he would have to state the course of knowledge which involved the patent in issue in the second action. The first action was brought in respect of the infringement of three letters patent belonging, the first to Mr. Edison, the second to Mr. Swan, and the third to a Mr. Gimingham. The date of the first is November 10th, 1879, No. 4,576; the second, January 2nd, 1880, No. 18; and the third, September 29th, 1881, No. 4,193. All three relate to the construction of an incandescent electric lamp, consisting of a glass receiver, or bulb, hermetically sealed, also by glass, containing a filament of carbon, exhausted of air and attached to platinum wire, which lead through the bottom of the glass for the purpose of conveying the current. The Edison patent, speaking generally, relates to the combination of filament and glass receiver or platinum wires, leading to the carbon filament inside. The Swan patent relates to the way in which the vacuum is obtained after the lamp has been put together. The Gimingham patent relates to the mode of attachment, or of making contact, between the platinum wire and the carbon. It is a special manufacture where the platinum ends and the carbon begins. Whatever the merits of Mr. Edison, in this case it could not be seriously contested but that the combination before them, the result of Mr. Edison's invention and description, solved the problem of electric lighting. For 35 years inventors, in America, on the Continent and in England, had been endeavouring to solve the question; they had arrived at certain points, and apparently the road was barred for further investigation beyond the points to which they had reached. He had not the smallest wish of underrating the very great part played by other men in this discovery, but his case was that that combination of Edison's solved for the first time the question of practical electric lighting by incandescent lamps. For the purposes of the case they had only to consider the question of the branch of lamps of the incandescent character. There are, in between the arc and the incandescent, some which have been called semi-incandescent; but these would be disregarded. Mr. Edison's specification was taken out on November 10th, 1879, and his final specification was filed on April 20th, 1880. He describes the invention in this way: "It is necessary to practically sub-divide the electric light into a great number of luminous points, so that lamps connected in multiple may be employed without the necessity of using conductors of great size for the current to the lamps. It is essential that the lamps should be of great resistance. In the Provisional Specification of Patent dated June 17th, 1879, No. 2402, I have set this forth and obtained lamps of great resistance by employing long lengths of platinum or metallic wires pyro-insulated and wound in such a manner that but small radiating surface is exposed to the air, although a great length of wire is used. My present invention relates to lamps of a similar character, except that carbon threads or strips are used in place of metallic wires. I use a block of glass into which are sealed two platinum wires. These wires serve to convey the current to the electric lamp within a bulb which is blown over the lamp and united to the glass block. The bulb is exhausted of air to about one millionth of an atmosphere. Upon the ends of these wires are two clamps that secure two other platinum wires. The burner consists of a filament or thread of carbon preferably coiled with the ends secured to the platinum wires. The main discovery, the discovery of Mr. Edison, in this connection was the utilisation of a filament or thread of carbon, meaning thereby a substance which is made into a filament or thread, or may be so made, before it is carbonised. Attempts to light by cutting down blocks of carbon from a thick piece to a thin piece, had been made and had failed, and even now fail, with all the knowledge we have at the present time. The point, the touch-stone, of the invention, and which has made the lamp from being a laboratory experiment into a practical, useful article, was the use of a filament or thread, that is to say, something made a filament before it was carbonised. "Fibrous material such as paper, thread, wood, or any vegetable or animal matter which can be carbonised has the end secured to platinum wires, the fibre is wound in such a shape as to expose the least amount of surface to radiation, such as in a helix or spirial. The helix is secured to the platinum wires by plastic carbon, and the whole is placed in a closed vessel free from air and subjected to a heat sufficient to fully carbonise the fibre and leave nothing but carbon. At the same time the effect of the carbonisation is to lock the carbon to the platinum wire and make good connection." That meant making carbon and platinum unite closely at the point of contact; otherwise, when the current went through there must be local action set up, which might tend to injure the connection between the two. "These wires are secured by the clamps to the two platinum wires in the bulb, and the bulb is exhausted of air and sealed; lamps of 100 ohms resistance may be made in this manner from which light from the incandescent carbon is obtained. The destruction of the fragile carbon by oxidation is prevented by the high vacuum which is obtained before sealing the glass bulb. Previously to my invention carbon sticks have been used, but they have only had a resistance of three or four ohms, and none have been used in vacuum bulbs composed entirely of glass except the leading wires, hence the difficulties of sealing leading wires into glass which would convey a current of sufficient strength to a lamp of but three or four ohms resistance, are too great to make such a lamp successful." This statement of the previous knowledge was practically accurate, but was not absolutely so, because undoubtedly Mr. Swan, whose merit in the invention was not one whit less than Mr. Edison's, had about this time conceived the idea of putting carbon sticks into a vacuum bulb composed entirely of glass. He had never thought of, or brought out the filament or thread part of it, but he had thought of, and had actually made a lamp in which the stick of carbon had been put in a receiver entirely of glass. Therefore, so far Mr. Edison was not quite right in saying that none had been used in vacuum bulbs composed entirely of glass except the leading wires; but as a practical question of what was generally known he was perfectly correct. "Hence the difficulties of sealing leading wires into glass which would convey a current of sufficient strength to a lamp of but three or four ohms resistance, are too great to make such a lamp successful, but when the resistance of the lamp is one hundred ohms or more the leading wires can be very

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small as they will then be a small factor in the total resistance of the lamp, and will not heat so as to crack the glass. Lampblack which has been placed in sealed crucibles and subjected to a white heat for several hours may be kneaded with tar until it reaches such a consistency as to allow of its being rolled out on flat plates to very thin wires which are sufficiently flexible to allow for coiling into helices. After they are rolled out to the proper length and size they are coated with a non-carbonisable powder or liquid and wound or coiled. The two ends are increased in size and secured to platinum wires; the whole is then subjected to heat in a closed tube, and the volatile constituents of the tar driven off and the balance carbonised, thus making a solid and homogeneous coil which can be then united to the leading wires of the lamp and a glass bulb blown over it and exhausted of air and the lamp is then ready for use. The non-carbonised material prevents the spirals from touching each other, until the whole has so stiffened sufficient to remain in its position. To assist in more rapidly manufacturing these spirals, I sometimes wind the flexible carbon wires between metallic spirals, which after the carbonisation of the tar are eaten away by acids, thus leaving the carbon intact. I also sometimes roll a thread within the compound of carbon and tar so as to allow of greater convenience in handling the same and the flexible carbon filament is not so liable to crack by its own weight in the act of winding. To increase the resistance of the lampblack-tar compound, I sometimes work into it a volatile powder such as powdered camphor, oxide zinc, but to make the light insensitive to variations of the current, a considerable mass of matter should be used in order that the specific heat of the lamp may be increased so that it takes a long time to reach its full brilliancy and also to die away slowly. To do this it is better to have the carbon as homogeneous as possible, and obtain the requisite resistance by employing a filament several inches long and winding the same in a spiral form so that the external radiating surface shall be small." Sir Richard Webster then passed to the complete specification of Edison's patent, which he read through, explaining various points to his Lordship. Proceeding, he said Mr. Edison was a skilled inventor and acquainted with the English patent law as well as the American; therefore he knew perfectly well that he might claim, and was entitled to various points of novelty, provided he claimed them distinctly. The carbon filament was a thing which he intended to claim and protect. In all his claims this special mode of coiling the carbon filament was a thing he meant to claim independently of the other use to which the carbon filament was put. The special mode of attaching the carbon filament to the platinum was also another thing which he meant to claim, and there were two combination claims which were independent of the shape of the filament and independent of the mode of attachment. The first is an electric lamp giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth. That was the novelty of this carbon filament. He was by no means sure that that claim might not be infringed by using that combination even where there was nitrogen gas inside the receiver. If his Lordship took one of the lamps and knocked it against his hand he would see that the filament would vibrate like a tuning fork for several seconds. That was of the greatest importance, having regard to the stability of the electric lamp for practical purposes. The advantage gained was in having lamps which might be put in railway carriages and places even near the traffic of streets, where the filament would be shaken but would remain unbroken. In addition to that there was the capability of shaping the bridge before carbonisation. In other words, the idea of shaping the conductor first, and then carbonising, was the root of the discovery which led to the success of Mr. Edison's lamp. Then the first claim also included securing the metallic wires; the second claim was a claim pure and simple to a carbon filament and a receiver, a glass through which the leading wires passed. That was in order to hit at people who said: "We do not use your particular platinum conductor; we have got other conductors, which we take up to the carbon filament." The third claim was as to the special coiled filament or strip arrangement, so that only a portion of the surface of the carbon conductor radiates; and the fourth was a method of securing in the carbonising chamber—carbonising the whole so as to get the close contact between the carbon and the platinum in the way described in the body of the specifications. Proceeding to the question of the anticipations, Sir Richard Webster said the defendants were advised by the most able counsel possible in this case, but he had never seen a case in which there was a greater abuse of the right or privilege of filing particulars of objections, for no less than 75 anticipations of Mr. Edison's lamp had been discovered by the ingenuity of Mr. Macrory and those who assisted him; and upwards of fifty of these had not the slightest reference to the matter. He would endeavour to state to his Lordship the leading landmarks of the invention prior to the date of the Edison patent. Before 1845 Mr. Justice Grove described a practical reading lamp formed by raising to a condition of illumination or incandescence a platinum wire on his table, and he (Sir Richard Webster) thought that Mr. Justice Grove had got quite as far in the year 1843 as a great many gentlemen afterwards got. About the time people began to see that carbon conductors were likely to be the sort of things that would do for electric lighting some day; and a man of the name of King in 1845 described a lamp which consisted of a carbon conductor, a stick or something of that kind, and in a Toricellian vacuum. It failed for various reasons, and among other reasons the vapour of the mercury which acted on the carbon, and no doubt the vacuum was not so perfect in practice as it was supposed to be in theory. From that time anybody could claim carbon conductors, and only some special mode of combination could be claimed. Then people found that the air in the vacuum very soon destroyed the carbon, and the lamp would only burn for a few seconds. Then came the platinum wire lamps, and notably a very remarkable discovery by Mr. Edison in 1879, whereby a platinum spiral in a very high vacuum was raised to a condition of incandescence. In his specification 2,402, of 1879, Mr. Edison disclosed things with regard to the making of a vacuum which had an important bearing on Mr. Swan's subsequent patent, and upon which he was free to admit an attack would be made on Mr. Swan's patent. Then Mr. Lane Fox, a gentleman who did a great deal of research and invention in this country, discovered that high resistance lamps were more likely to succeed than low resistance, and he devised a number of clever means of mixing up non-conducting material with conducting material, as for instance, asbestos with carbon, for the purpose of increasing the resistance of the bridge across, but he wholly failed to hit upon the idea of the carbon filament, or a thread which could be made into shape previous to its being carbónised. So far as the prior knowledge was concerned, that was was the condition of matters, boiling down the whole of the 75 anticipations. There was one other thing which was certainly very remarkable, and one very near in some ways to be a great discovery. He believed he held in his hand the only lamp, in respect of which, so far as he knew, it might fairly be said that Mr. Edison's statement of knowledge was incorrect. Mr. Edison thought a sealed glass bulb was entirely new. Some time in the year 1878 Mr. Swan exhibited this lamp at Newcastle. So little importance did he attach to it as a practical lamp that he did not patent it, and it never went further than this experimental lamp, and although in one sense a step in discovery, it was open to serious objections. It was the nearest approach to Edison's lamp which could be suggested. It consisted of a carbon pencil, a piece of carbon sweated or rubbed down to a thickness of something like the 32nd of an inch, a rigid piece with no flexibility; no power of being bent into shape prior to carbonisation, and having, also, the great disadvantage of requiring very large leading wires to go through the lamp, which would inevitably have the defects Mr. Edison pointed out. It was not practicable; it was not Edison's at all; it was not the carbon filament. He admitted there was a sealed glass bulb round the carbon pencil or stick; and Edison stated that he thought the glass bulb had not been used. But it had often been pointed out that an erroneous statement of the state of knowledge did not invalidate a patent. With regard to the vacuum Edison probably thought, and was right in thinking, that when you had such an extraordinarily attenuated filament as he described, the air shut up in the filament itself might be disregarded; but he discovered, in common with other people, that these conductors did contain occluded air, and in the earlier patent already mentioned, in describing a platinum lamp, he said you can improve your vacuum by passing an electric current through the platinum before the exhaustion is complete, which will drive out some of the air in the vacuum, which air will again be driven out by the exhaustion; then you can pass another current through and drive out some more; you can then finally seal your bulb. It is quite true Edison did not describe in this specification the mode of driving out the air from the carbon filament, nor was it necessary, because he has not claimed any special mode of manufacturing his vacuum. He could not say whether Mr. Swan actually re-invented the whole invention; very likely he did; but he certainly found out that in carbon lamps made as he described the fault was the occluded air which lowered the vacuum after the current was sent through, and accordingly he patented an improved method of making the vacuum. On page 2 of Swan's specification, No. 18 of 1880, he said: "It is well known that in that class of electric lamps in which light is produced by the incandescence of a carbon conductor contained in a closely sealed globe or glass, more or less exhausted of air, two difficulties have hitherto impaired their utility. (1st.) The carbon conductors in process of use gradually wasted, and ultimately broke. (2nd.) The interior surface of the globe containing the incandescent carbon became coated with a carbonaceous deposit, and obscured the light. I have discovered the means of avoiding both these faults, which are dependent the one upon the other, as follows, that is to say: I have found that if the globe, or vessel of glass containing the carbon to be rendered incandescent, be exhausted of air to a high degree of exhaustion, by means of a Sprengel pump, whilst the carbon contained within it is raised to the same, or a brighter degree of incandescence, as that ultimately required to be produced in using the lamp, and if the lamp be hermetically sealed whilst exhausted of air, under the conditions specified, the lamp so prepared is durable, both the faults above-mentioned eliminated, the incandescent carbon enduring without waste, and the interior surface of the glass globe keeping free from carbonaceous deposit." The point of weakness about this patent was that it was not confined to the filaments only. "In carrying out my said invention I take a rod, filament, or lamina of carbon, and a length and thickness proportioned to the current to be employed in heating it; for example, it may be two inches in length and 1-50th to 1-100th of an inch in sectional area. This rod, filament, or lamina, I clip at its extremities by means of a pair of platina clips, to which are attached platina wires, which serve for conducting the current through the lamp." There was some little difficulty in saying whether he meant filament in the same sense that Edison did. There was nothing to indicate that he meant a thread which could be carbonised after it had been shaped, or anything of that kind. The words, "rod, filament, or lamina" together, looked as

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if he was using them independently of their particular form, but he thought he was right in saying that he contemplated something there more than was made before. He was free to admit the word "filament" did not occur in the claim. On the other hand he thought he was justified in pressing that it was a claim to a combination lamp in which the carbon has been exhausted in the way specially described. Mr. Swan's specification was filed on January 2nd; Mr. Edison's was not known to the world until April 10th, therefore there was no publication in England of Edison's invention prior to the January 2nd. A point arose on this which had never yet been decided. Where there had been a provisional specification published and no patent is taken out upon that, that provisional specification is not a publication of the invention, so as to anticipate a subsequent invention, if that subsequent invention was described within the period of six months while the provisional specification was secured. But in this case Edison's patent went to seal, formed the subject of a grant by the Crown, and therefore the question arose as to whether or not there could be a second grant for that same invention. The point had never been decided, but it had been discussed and touched upon in one or two cases.

Mr. JUSTICE BUTT: I do not quite see the bearing on this point. You are here on the two patents. Is the point this, that if they get rid of Swan because he had been anticipated by Edison, then it is no use to say it is a joint patent?

Sir RICHARD WEBSTER: It is not joint; it is separate. I am only showing that they will say if we can bowl over Edison they hope to bowl over Swan.

Mr. JUSTICE BUTT: That is to say, if we bowl over Swan by Edison.

Sir RICHARD WEBSTER: No! They only get rid of Swan; but still it is of importance to get rid of that as well. They desire, if they possibly can, to be free to work without paying a royalty upon Swan's patent. What the defendants say with regard to this particular specification of Mr. Swan is that Edison by his patent, No. 2,402 of 1879, showed you how to perform an analogous operation with regard to platinum, and also said that a carbon stick may be treated in the same way. My answer is that Edison was doing it for the purpose of improving his platinum as material, that he was not pointing in any way to the same thing, and further than that, it will be for your Lordship to say whether or not the description of Mr. Swan, applicable to the carbon lamp, is anticipated by that general description of knowledge, remembering that Edison was not contemplating a carbon lamp but a platinum lamp. And I think your Lordship will be satisfied by the evidence that it by no means follows that because it was a prudent thing to drive the air out of a filament or wire, it was equally prudent to drive it out of a platinum filament or wire. It might have had just the effect of making it friable or bad. On that nobody could say the one thing was a disclosure of the other. Sir Richard Webster then proceeded to describe Gimingham's patent. Gimingham took his platinum terminal sheet and flattened it out until it assumed the shape of a spade. Then he turned it round through a die or mandrel, until it assumed the shape of a tube. Into that tube he dropped the end of his carbon filaments, and by the combined spring of the carbon and metal tubular parts the carbon is held firmly in place in the said terminals. Then he claimed improvements in electrical lamps consisting of attaching the carbon of the terminals. He had now described all three patents, and he thought he might say that, except so far as putting a proper construction upon Edison's specification, the infringement in the ordinary sense of the word would not be denied.

Mr. CHARLES: I cannot admit that.

Sir RICHARD WEBSTER: I do not ask you. I said I think it will turn out that, assuming the patent to be good and to have the construction for which I am contending, the infringement will not be denied. We have the glass bulb, we have the carbon filament, that is to say, this thread or thin strip of wood. The particular Edison lamp which I have handed up is made in one of the ways indicated in the specification, of a piece of bamboo, finely divided and then carbonised. Lastly, I believe it will turn out that the attachment between the carbon and the platinum is made by making a formation of the end of the platinum, twisting it round, and inserting the pieces of carbon. We have broken several of the lamps, and we find they were constructed in that way, and I do not think that will be disputed. Sir Richard Webster then said that as he did not intend to trouble his Lordship with another opening upon the second case, and as it would be necessary to consider the patent upon which the second action was brought, he might as well tell his Lordship what it was now. Cheesborough was the man who took out the patent, but it was discovered by Messrs. Sawyer and Mann that the carbon might be very much improved for electric purposes if it was subjected to a certain treatment; that was, if it was put into a hydro-carbon gas or liquid and then an electric current passed through it. That had the effect of consolidating or making uniform the structure or substance of the carbon which formed the conductor, and that particular invention consisted in improving the material of the carbon itself, partly by deposit and partly by some other action, by inserting it in a hydro-carbon liquid or fluid, and by passing the electric current through. When they came to that part of the case they would assert that they had as to that a distinct admission that those carbon filaments, after having been made in the way described, had been subjected to that treatment by the defendants. He mentioned that now in order that his Lordship might understand that he had said enough for the purpose of indicating the four rights in respect of which the two actions were brought, although he quite agreed they must be fought separately. I think your Lordship will be of opinion, when you have heard the evidence in this case, that, subject to the one somewhat difficult question so far as affects Mr. Swan's patent, there is no doubt, at any rate upon the other two patents, and I shall submit on that also, that the plaintiffs are entitled to recover.

Sir FREDERICK BRAMWELL was then sworn, and examined by Sir Richard Webster. He said he had studied the matter of electric lighting for a long time, and had become acquainted with the various lamps and improvements brought out from time to time. In Edison's specification No. 4,576 of 1879, he found a vessel made entirely of glass containing a carbon filament attached to conducting wires, which wires are sealed through the glass. This vessel is to be exhausted of its air to a very great degree, the patentee mentioning that only one millionth of an atmosphere might be left. The patentee says with a lamp of that construction light can be obtained by rendering the filament incandescent by means of an electric current. The specification contained different descriptions to enable a competent workman to construct such a lamp. The advantage of a lamp made with a filament was that you are enabled to get an extremely high resistance where you desire it, that being advantageous for the purpose of incandescent lighting by multiple arc. Having described the method of lighting by multiple arc, and the system of arc lighting, Sir Frederick Bramwell stated that this patent related solely to the incandescent light. According to the specification the filament was to be made before carbonisation, and a variety of ways were described in which it might be formed and then carbonised.

Would you tell my lord what are the advantages or the necessities for the particular combination of coiled filament, the subject of the third claim, which Mr. Edison refers to as being desirable when there is an unsteadiness of the current?—Mr. Edison there is pointing out that by adding to the quantity of the filament you have, as it were, a species of reservoir which will neither so rapidly increase its glow nor so rapidly lose its glow as when there is a less quantity. Then he says you cannot get that quantity by having it in a straight wire, because if you did, you might probably not get heat enough; but if you coil it, then the internal reflection of the coil from one side to the other prevents that part from being a radiating surface in the ordinary sense, and in that way you can get this greater length and greater resistance, and what I may call greater capacity.

He says that if the current is unsteady the result is that you will have steady light, and if the current is steady you do not require this coil?—Yes; he says at page 4, line 38, that if the current is steady the defect of the rapid appearance or disappearance, does not show.

As a matter of fact are these lamps with the plain filament equally effective for the purpose of lighting?—Yes. The wire nearly bent going out and back again.

As far as you know was the combination described in Mr. Edison's specification new?—So far as I know. I have gone through the suggested anticipations, and so far as I have gone I have not overlooked anything. I do not find anything in them to anticipate the plaintiff's lamp as I have described it.

Is carbon well-known as a conductor of electricity?—Yes; all arc lights depend upon that.

For how long had attempts been made to utilise carbon in one shape or other in connection with incandescent lighting?—1845 was the earliest that I know of. A man named King had a sort of barometer tube with an enlarged part at the top: a wire led in through the glass top, an attachment to a stick of carbon, and a wire led out through the mercury at the bottom, and on this tube being put upright the mercury fell, and left the upper part in as vacuous a condition as the Toricellian vacuum can produce. That was publication of the use of carbon as an incandescent conductor. Attempts had been made to get rid of the perishing of the carbon, or other conductors, by the action of air inside the bulb by replacing atmospheric air by some gas which would not combine with the carbon, and would not burn it. So far as I remember at the moment the experiments were all made in nitrogen.

Had other conductors than carbon been used in incandescent lamps?—Yes, platinum and an alloy of platinum and iridium. No practical electric lamp that has ever survived in commercial use has been introduced with such conductors. But I have seen lamps of that kind at work, and I believe before the date of the patent I have a distinct recollection of seeing them at work at a soiree of engineers held at South Kensington a good many years ago; I think before 1879. There is no doubt you can raise platinum to incandescence. But since the carbon filament was described it has had the monopoly.

So far as resistance was concerned had Mr. Edison and Mr. Lane-Fox pointed out the desirability of high resistance?—Mr. Lane-Fox had pointed out the desirability of high resistance.

Taking the Swan Newcastle Lamp, exhibited before the date of Mr. Edison's patent, will you tell us what that is so far as you can examine it without breaking it?—It is obviously glass. There are two large wires sealed through the two ends of the lamp, which from their appearance are platinum. There are the remains of a tube that has been finished off by the glass-blowers. There is also a globule of mercury in the lamp, and both these ends are consistent with this lamp having been exhausted by a Sprengel pump. Of course I cannot tell unless I break it that it is in a vacuous condition; I have no doubt about it. There is a little globule of mercury that has got in from the Sprengel pump, no doubt. In between these two wires there is what I should call a pencil of carbon; I cannot tell you the exact diameter, but it is a very appreciable fraction of an inch. It lies

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rigidly between the ends of the two conducting wires, and is in my opinion in no sense to be called a filament of carbon.

Just look at the two ends of that carbon or pencil. Are they thicker or the same diameter just above where they join the platinum?—I think they are the same diameter, but there is something of a larger diameter, which, however, I believe to be a piece of metal.

I think by the magnifying glass you could see the platinum wire as it comes on to the carbon?—I have seen it.

I do not know whether you can tell from the view whether that has been worked down from a thicker piece of carbon or not?—I have no doubt it has. The appearance is quite consistent with that. That would be a lamp of low resistance. The carbon is of great sectional area.

You have already said that that carbon pencil is not in any sense, in your opinion, a filament of carbon?—Yes. Mr. Edison has told you that that which he wants can be obtained by a mere thread, an absolute thread carbonised, and when he comes to that kind of filament that he proposes to make out of the sort of paste he tells you that it is to be $\frac{1}{1000}$ths of an inch. This, I should say, would be more like a 22nd or 24th, judging by the eye.

Have you ever seen a lamp of that kind in commercial use, or burning at all?—Never. So far as I know it has never been used experimentally, except by Mr. Swan. I know by the particulars of objection that one of them was broken up by a gentleman of the name of Proctor, who gave a lecture on what he called the smoke inside an electric lamp. He wanted to break it up in order to discover what the smoke was composed of.

Do you believe that any of the publications or disclosures were commercially practical in incandescent electric lamps before December, 1879?—None of the carbon ones certainly. The metallic ones for a long time appeared as though they were about to be successful lamps. When the solution came of the carbon filament I think they had all been practically dropped.

Has the carbon filament been of great practical use, and largely adopted?—Yes; it is in use over your heads at the present moment.

I will just ask you to describe that part of the Swan patent which deals with the question of getting out the occluded air in the carbon. What are the causes which lead to the longer or shorter life of the lamp, so far as vacuum is concerned?—Two. One, the combination of the oxygen of the air with the carbon, really burning it away to the extent to which there is air there. The other is that which is generally known now, I think, as the washing of the carbon, the absolute friction and attrition of the circulation of the air due to the difference of temperature in the different parts of the lamp. The effect of passing a current through, then exhausting, and then sending another current through is that the carbon and the vacuum together drive out from the carbon any occluded gases and the vacuum being continued at the time removes them, and then after they are removed the lamp is sealed. That improves the light of a carbon lamp.

What was known, as to driving out air, prior to 1880? So far as I know the thing that was known is to be found in a prior specification of Mr. Edison, No. 2,402, page 437. Mr. Edison is speaking primarily there of one of the platinum iridium incandescent lamps. At page 9 of the final specification, line 33, he says:—"From my researches and experiments I am led to believe that the cause of the rupturing of the metal when brought to incandescence is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores directly during the rolling or drawing of the sheet or wire. These gases or air when subjected to a high heat are greatly expanded and rupture the metal, and cannot be driven out only by slowly heating the metal." Then he says: "I have also discovered that the loss of weight and apparent voltatilisation of the metal is due to the action of the air or gases against the highly-heated surface." That includes his washing of platinum iridium wire. Then he says that having ascertained the causes of these defects, he set himself to cure them; and then follows the description: "A spiral of platinum wire is placed in a glass bulb with its ends passing through, and sealed in the glass, and the air exhausted from the bulb by a Sprengel pump until the discharge from a three-inch induction coil will not pass between two subsidiary wires in the bulb, the ends of which are 4 millimètres apart." The power of the electric spark to pass through a given distance is used as a test of the vacuum. Then he says: "The wires of the spiral are then connected to a magneto-electric machine or battery, whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150° Fahr.; it is allowed to remain at this temperature for 10 or 15 miuutes. While thus heated the air or gases in the pores of the metal are expelled by the action of the heat and the expansion of the gases which tend to pass outward of the vacuum." Then he says the mercury pump is kept continually working. At the end of 15 minutes he raises to 300° Fahr., and he waits for another 10 or 15 minutes, and so he goes on until he raises it to a dazzling incandescence, a light of 25 standard candles. "Whereas before treatment the same spiral would only emit a light equal to three candles before attaining the melting point." Then he says at line 10 on page 10: "The wires subjected to the process of freeing them from air or gases are found after the process to have a polish exceeding that of silver and obtainable by no other means. No cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and no volatilisation takes place, as there is no deposit upon the glass bulb, nor does a delicate balance show any loss of weight in the spiral even after such spiral has been burning for many hours continuously, because the spiral is in a vacuum so nearly perfect that the action of the gaseous molecules is reduced to the minimum, and were it possible to obtain an absolute vacuum there would be no loss whatever."

(To be continued.)

NOTES.

Bank Lighting.—The new premises of the English Bank of Rio de Janiero, Moorgate Street, which have lately been occupied, are lit on the Electrical Power Storage Company's system by 50 incandescent lamps. A 4 H.P. new type "Otto" gas engine drives a dynamo which charges 31 of the 15 L cells in glass boxes; the whole installation being in the charge of the hall porter, as in the case of the New South Wales Bank. Both these instances show conclusively, were such proof required, that if the installation is properly put down and carefully arranged, there is no necessity whatever for having skilled labour to work it; and further, that a gas engine can be put down in the busiest thoroughfares without any risk of causing annoyance to the neighbours.

The Electric Light in Carriages.—The success of the incandescent electric lamp for private carriages in Paris is pronounced complete. The lamps are connected by wires with small storage batteries under the drivers' seats. They are small in size, being only about eight inches square and four inches high, each of the batteries being capable of supplying a lamp of 5 candle-power for a period of some six hours. During the day they are removed and charged, and at night they are ready for use.

Investigating the Electric Light in Darkness.—Mr. Justice Butt, who is trying an important incandescent lamp patent case, must have been strongly impressed with the truthfulness of counsel and witnesses on Tuesday when they spoke of the safety and reliability of electric lighting by incandescent lamps, for, as a commentary upon the statements made, about an hour before the usual time of adjournment the incandescent lamps with which the Court is lighted suddenly ceased to give light. There was just enough daylight left to enable the Court to adjourn without danger, but not enough for the continuance of the sitting. Mr. Moulton, in response to some bantering remarks, explained that the breakdown was not due to the lamps at all, but to the machinery, or perhaps to some vagary of the engineer. The lamps in the corridor outside the Court remained alight, so it was evident the collapse was not general throughout the building. We would advise more care and greater supervision in the electric light department at the Law Courts.

Leeds Town Council and the Electric Light Bills.—The Leeds Town Council last week resolved to petition Parliament in favour of the Government Electric Lighting Act (1882) Amendment Bill. Alderman Emsley, in moving the resolution, said he did not think that Leeds was now very dependent upon any electric company with regard to the electric light. Its hydraulic powers would give Leeds a position which no other town in the United Kingdom would have. All that a shopkeeper or householder would have to do when the Compressed Air and Hydraulic Power Bill was passed was simply to have a dynamo, all power being furnished at a very reasonable price. He did not think that companies would have any chance of profit in coming to Leeds, except in the way or selling their dynamos.

The Albert Palace Lighting.—Our expectations have been verified as to the electric lighting of this palace; the contract has been given by Mr. Holland to the Jablochkoff and General Electricity Company, which gave him such satisfaction at the Covent Garden Circus.

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The Uses of the Telephone.—A few weeks ago we spoke of the adaptation of the telephone as a means for indicating the results of the shooting at rifle ranges. The Western Counties and South Wales Telephone Company has recently supplied the Brownsdown ranges with telephonic arrangements, and the company's Portsmouth District Superintendent, Mr. J. H. Sandy, has just made a report upon the system. It is addressed, under date May 8th, to Mr. H. F. Lewis, the general manager, and reads as follows:

"Mr. Hovell's Experiments at Firing Ranges.—I visited Browndown ranges yesterday, with the desire, and by appointment, to see the working of the telephone for the purpose of the marker giving the result of each shot by telephone instead of by flag signalling. I was in the signal hut over an hour, and I must say that the result was all that could be wished. The advantages appear very great over the old system. In the first place, the click of the rifle could be distinctly heard, which prepared one to watch the target for the mark, and thus relieved your eyes from the constant watching of the white glaring target. Again, the man can give the actual result of each shot, whether to the right, left, above, below or a miss, and give the *exact* result, whereas the flags could give but very imperfect information. Mr. Hovell was much pleased to see me, and fully explained the improvement to me. He thinks that ultimately the system will be universally used, and he will continue his experiments with this object."

We may add that the arrangements for the Brownsdown ranges are similar to those supplied by the same company for the diving experiments in connection with the use of the telephone on board H.M. ships *Vernon* and *Excellent*, and which have been so successful that they have been generally adopted for diving purposes.

Free Telephonic Communication.—The Western Counties and South Wales Telephone Company, who are about to establish an exchange at Southampton, have undertaken to connect with their system in that town the principal police-station, the fire brigade headquarters, and the infirmary, free of charge.

Telephone Tariff Charges.—The National Telephone Company, Limited, with the view of increasing the telephone facilities to subscribers and the public, has resolved to modify its existing tariff for exchange, private, and Trunk wires. List of subscribers and full particulars may be obtained at the offices of the Company, 13, Royal Exchange Square, Glasgow.

Telegraphic Communication Wanted.—The apparent likelihood of a European war should draw the attention of the Admiralty to the desirability, not to say necessity, of establishing a line of telegraphic communication with Bermuda, which appears to be entirely isolated. At present the quickest communication is from New York, and occupies 50 hours in transit. A Gibraltar correspondent says that the people of Ceuta are complaining bitterly that although plans have been matured for the last five years to connect that town with the peninsula by submarine telegraph, nothing has yet been done. Tangiers is more favoured.

Presentation of Medals to Telegraphists.—On Saturday, at the close of the annual inspection of the Queen's Edinburgh Rifle Brigade in the Queen's Park, by Colonel Macpherson, C.B., five telegraphists were presented with medals for serving in Upper Egypt and the Soudan. The names of the men were Andrew Isles, Daniel Thomas, Charles E. Gray (Upper Nile), and Thomas Smith and R. W. Newlands (Suakim). The presentation was made by Mrs. Cunynhame, wife of the Surveyor General for Scotland. The number of Volunteers on the ground was 2,196, under the command of Colonel J. H. A. Macdonald, M.P.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to May 8th, 1886, amounted to £135,000 against £140,000 received from April 1st to May 9th, 1885.

Non-Delivery of Telegrams. — Mr. Forwood asked the Secretary to the Treasury in the House of Commons, on Monday, whether the refusal of the postal authorities in Liverpool to deliver a telegram sent from Oswestry on the 16th of April, addressed "Pierce and Hartley, Solicitors, Liverpool," and one sent on the 20th of April, at 10·37 a.m., from Coniston, addressed "Thornley and Cameron, solicitors, Liverpool," on the ground that "the delivery could not have been effected without reference to a directory," complied with the latest instructions of the Postmaster-General in reference to the delivery of telegrams. Mr. H. Fowler: Although it is open to doubt whether in the cases referred to the senders had "done their best to give a sufficient address," the Postmaster-General thinks that the addresses given were sufficient to insure the delivery of the telegrams, and renewed instructions on the subject have been given.

The West India and Panama Cable.—In renewing the subsidy of the West India and Panama Telegraph Company, the discussion in the Demerara Court of Policy turned upon the defective state of the cable, the meagre and uncertain character of the information sent, the enormous charges made by the company for the transmission of messages, and the expediency of enforcing the penalty for interruptions. The discussion was rather warmly maintained. The Attorney-General said he thought there should be a line of telegraph communication between Great Britain and the West Indian Colonies, passing through the dominions of Great Britain; that this had apparently been recognised by the late Home Government in offering a subsidy for a line of cable from Halifax *viâ* Bermuda to Jamaica; and that if that were done there could be no doubt the Colonies themselves would lay down their own line to connect Jamaica with the other West Indian Islands.

Another French Atlantic Cable.—The *Daily News* Paris Correspondent telegraphed last week that M. Granet, the Minister of Posts and Telegraphs, had granted a charter to a French company for laying a cable between Brest and New York, *viâ* Guadeloupe. All the directors were to be French, and it had been *stipulated that the cable was to be manufactured in France and laid by French vessels.* An important clause in the contract was that the State will guarantee a certain interest on the capital. In this matter the *Daily News* Correspondent is not quite correct, as foreign firms are admitted to tender for the proposed cable.

Another Fracture of the French Atlantic Cable.—The French Cable Company, having ascertained that one of the cables has parted some 30 miles off Lands End, has sent a steamer to repair it. The steamship *Lady Carmichael* arrived at Penzance on Saturday night, and left the following day for the scene of the rupture.

How are the Mighty fallen!—We hear that the ss. *Great Eastern* has been secured by Messrs. Lewis and Co., of Liverpool. The vessel will be moored in the Mersey, and used for exhibition purposes afloat. It appears to us that the only difference between her present and past career is that instead of, as now, being made an exhibition of by others she previously made exhibitions of herself. Be this as it may, we learn that she is to be electrically lighted throughout, and that the work is to be carried out by the Jablochkoff Company.

The Delany Multiplex Telegraph.—In reply to several enquiries respecting the publication, last week, in a contemporary, of a guide to the English Postal Telegraph officers for fixing and working the Delany telegraph, we are enabled to say that the directions therein given have been subjected to very considerable modifications, and that the guide may therefore be considered more or less obsolete.

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Technical Electrical Apparatus.—In the course of his lectures on science teaching, at the Society of Arts, Prof. Guthrie gave the following particulars of his mode of proceedure in regard to electricity:—"The principal pieces of apparatus constructed in this branch are:—A gold leaf electroscope; a differential condenser; a sand-dropping accumulator; a Leyden jar: an electrophorus; a dry pile; a voltaic cell; a differential galvanometer; a resistance bridge; a set of resistance coils; a tangent galvanometer; a potentiometer; a thermo-element; a thermopile. And by these apparatus typical experiments and measurements, of which the following are a few, are made:—The study of magnetic curves; the action of the current on the needle; the relation between length, weight, and resistance in wires; the effect of temperature on resistance; the law of divided circuits; specific resistance; electromotive force; internal resistance of cells, and so on. Electricity, especially voltaic, lends itself perhaps more abundantly to exact measurements in the elementary laboratory than the other branches, and it is on this account, and because it is the last subject treated of, and so claims any spare time at the end of the term, that it occupies a rather prominent part. I do not hold that it has really any greater educational value than the other branches, and certainly in a general educational course it is not for me to give it prominence, because just now it has a considerable technical development. I trust the time may never come when any branch of physics will be considered as of comparatively little importance in general education. Excepting as to the subjects of mining and metallurgy, our schools are without technical training."

Electric Street Cars.—Of all the newspapers which have ever reached this office, from whatsoever clime they came, the Independence *Sentinel* is by far the most remarkable for the inaccuracies which it contains. Scarcely a paragraph but contains glaring typographical or grammatical errors. Perhaps, therefore, it was the best receptacle for a paper on "Electric Street Cars," which was recently read before the Query Club of Kansas City, and reported in its columns. The character of the paper may be gathered from the following extracts. It commences: "An examination of the history of human progress should incline us to be astonished at the stupidity rather than at the achievements of the intellect of man." . . . . . .
"Two difficulties have stood in the path of success from the first, and were not thoroughly overcome until our townsman, Mr. John C. Henry, set his wits to work about it. One of these difficulties was to convey the current to a moving car and yet not waste it or make its use perilous to street travel. Some inventors used the sails as conductors, others placed conductors in conduits beneath the cars; others carried accumulators in the cars, others used tubular over-head conductors slit throughout for the introduction of a brush; in all of these the method is either wasteful and inadequate or extremely expensive. It was reserved to Mr. Henry to suggest over-head wires with a little wheeled contact carriage to travel along them and transfer the current to the car. By this simple but perfect device one of the bug-a-boos of electrical locomotion is destroyed."

Information Wanted.—We understand that the *Volta* is engaged in picking up the old Direct Spanish cable between Bilbao and the Lizard. It would be interesting to know if there is any connection between the work on which she is occupied and the recent breaking of the Atlantic cable which the *Lady Carmichael* has been sent to repair.

The Price of Descriptive Articles.—Mr. W. H. Forbes, president of the American Bell Telephone Company, told the Telephone Investigating Committee of the House that the *New York Times* was paid $1,200 for publishing on the 1st of January last a four column news article about the development of the Bell telephone.

New Electrical Generators.—The construction of electrical generators of the type advocated by the Hon. Charles A. Parsons, suitable for use on board ships where lightness, compactness and simplicity were of the most importance, has, we learn from the *Mechanical World*, been carried on at the Victoria Works, Gateshead-on-Tyne, by Messrs. Clarke, Chapman, Parsons & Co., and the largest sized generator made by them has run at a speed of 9,000 revolutions per minute with 50 lbs. steam pressure, giving a current of 200 ampères with an electromotive force of 80 volts. On several occasions with this load this generator had run for several days without stopping. The generator consisted of a compound turbine motor, coupled directly to the armature of the dynamo; both were mounted on bearings of special construction, and were lubricated automatically and continuously. The speed was governed by a combination of fan-governor and subsidiary electrical control, which kept the electromotive force to within one volt of the normal pressure. The magnets are shunt-wound, and take about three ampères of current, and the armature is one of very low resistance. The total weight of this generator is 15 cwt., and the steam consumption per electrical H.P. is given as being very moderate.

The British Association.—The programme of arrangements for the Birmingham meeting of the British Association has just been issued. It meets on Wednesday, September 1st, when Sir Lyon Playfair resigns the presidency, which will be assumed by Sir William Dawson, C.M.G., F.R.S., the eminent Canadian geologist, Principal of M'Gill College, Montreal. In the permanent staff there is no alteration, except that the new secretary, Mr. A. S. Atchison, assumes full responsibility for the first time in place of Prof. Bonney. The following are the presidents of the various sections:—A, Mathematical and Physical Science, Prof. G. H. Darwin, F.R.S.; B, Chemical Science, William Crookes, F.R.S.; C, Geology, Prof. S. G. Bonney, F.R.S.; D, Biology, William Carruthers, F.R.S.; E, Geography, General Sir F. J. Goldsmid, K.C.S.I., C.B.; F, Economic Science and Statistics, John Biddulph Martin, F.S.S.; G, Mechanical Science, Sir James N. Douglas, M.I.C.E.; H, Anthropology, Sir George Campbell, K.C.S.I., M.P. On Thursday evening, September 2nd, there will be a *soirée*; on Friday, September 3rd, at 8.30, a discourse on "The Sense of Hearing," by Prof. W. Rutherford, M.D., F.R.S.; on Monday evening, September 6th, at 8.30, a discourse on "Soap Bubbles," by A. W. Rücker, M.A., F.R.S.; on Tuesday evening, September 7th, at 8 p.m., a *soirée.*

Electricity Analysed.—The author of a pamphlet bearing the above title has ere this figured in our notes columns. His name is William Boggett, ætat 90; he hails from Chelsea, and is best known in connection with some experiments of an interesting nature which he performed with the aid of his niece, to show that the electric state of males and females respectively is essentially an opposite one. Dealing in this, his latest production, with matters with which we have a more intimate acquaintance than with the above, this latter-day Chelsea sage thus learnedly proceeds: "Messrs. Gaulard and Gibbs have proved the great amount of electricity in the atmosphere by the large quantity they obtained from a dynamo to light several stations on the Metropolitan Railway being passed into the *primary wires without loss*, but went on without any diminution into the secondary wires, from which the supply of light was given to several stations on the line. The secondary wires, therefore, could only have received its lighting power by induction from the atmosphere." We should have been inclined to attribute the high percentage of return in the Gaulard-Gibbs apparatus to the employment of this atmospheric dynamo were it not for an admission made by Mr. Boggett, which somewhat shakes our faith in him. He candidly says: "As an uneducated man I deem it proper to apologise for advocating opinions directly at variance with those held by the highest scientific authorities."

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Crompton Dynamo Tests.—A friend writes thus:—"Mr. Sydney F. Walker's letter of last week contains two serious errors regarding the working out of the results which require correction. First, the I.H.P. given to the exciter does not enter into the calculations as Mr. Walker suggests, and should *not* be added to the I.H.P. of the main engine, since the watts absorbed in excitement were included in the gross electrical output and deducted therefrom, thus leaving a nett electrical output on which to base the efficiency. The watts employed to excite the machine are thus included in the I.H.P. tabulated, and the method of arriving at the final results as printed in the report is correct. Secondly, by running the engine light and comparing the I.H.P. with that developed when fully loaded an *apparent* efficiency of the engine is given only, and not a *real* efficiency, since the work absorbed by friction is greater when the engine is loaded, and therefore does not accord with that obtained from the diagram taken when running light."

Cells for Accumulators.—That very considerable difficulty is experienced in obtaining outer cells for accumulators, which shall at the same time be cheap and durable, is well known. The only material which has hitherto proved satisfactory as regards durability has been glass, but cells of this substance are expensive. Porcelain has been tried, but we believe not with great success owing to the powerful effect which the acid solution under the influence of the disengaged gases has upon the material, the glazing becoming rapidly destroyed. Messrs. Price, Sons & Co., of Bristol, have recently introduced a highly glazed vitrified description of stone ware which is likely to prove useful for accumulator and other purposes. The makers guarantee that the ware shall last 12 months under the influence of the disengaged gases in accumulator cells. The durability of the ware is no doubt due to its high vitrification, which gives it the nature of glass. An improved form of insulator for supporting battery troughs is worthy of note; the upper portion of this insulator, on which the trough rests, is made of a mushroom form, and is larger in diameter than the base, so that any drip which may take place falls clear of the lower part of the insulator.

Electrical Works in the British Museum.—A catalogue has just been compiled at the British Museum comprising all the works acquired during the years 1880–85 in all modern languages except Oriental, Hungarian and Sclavonic, arranged according to subjects. The subject "Electricity" is a remarkable one for the number of entries under it. They fill 10 pages in double columns, and about half refer to the electric light. Fifty telegraph codes were published in the five years, exclusive of innumerable private and cypher codes.

Electricity in the Royal Navy.—The *Dreadnought*, which has just arrived in Suda Bay after undergoing extensive repairs and alterations at Malta, has been fitted with a "Victoria" dynamo and incandescent lamps for internal lighting. The *Superb*, which has been conveying supernumaries and stores to the British fleet in Suda Bay, has been having target practices at night, by means of the electric light. From some cause or other, however, the latter was by no means so powerful as was necessary, and the experiments were not a success. The torpedo ram, *Polyphemus*, also at Suda Bay, has been practising signalling with her new masthead semaphore, the *modus operandi* of which has already been touched upon in the columns of the Electrical Review. The signals were read with great ease by the various vessels of the fleet, and the system was generally admitted to be far superior to that at present in vogue. As the apparatus can be easily fitted to the masthead of any ship carrying the electric light, the Admiralty would do well to lose no time in superseding the old method.

Wire Gauges.—Mr. Carl Hering publishes in the New York *Electrician and Electrical Engineer* for the present month a combined table of all the principal wire gauges used in America, England, and France. By the use of this table Mr. Hering thinks that many calculations become simplified, while others can be avoided. In the same journal the author contributes the second paper of a series on Dynamic Electricity.

Arc Lighting Plants.—If a man desires to erect an expensive house he generally consults an architect, and if you propose to go into the electric light business it is far more important that you consult and be guided by the advice of an electric light engineer. So says Mr. J. M. Offord, the superintendent of the Bridgeport (Conn.) Electric Light Company, who this month publishes in the *Electrician and Electrical Engineer*, of New York, the first portion of an article which promises to be of much interest and value, on "The Installation and Management of Arc Lighting Plants."

American Arc Lighting Industries.—The most favourable indication of the permanent prosperity of the electric lighting industry in America is the fact that it is quietly settling down upon the basis of ordinary commercial undertakings, and is now generally free from that artificial stimulus which was originally given it for the purpose of floating various speculative schemes. It appears now to offer inducements for the investment of a considerable amount of capital in the aggregate, which, under careful management, will earn a good profit. Once fairly established, a local electric lighting company advertises itself, and will secure customers, as it gradually evinces its ability to render good service.

The Queen's Visit to Liverpool.—Newsham House, which was occupied by the Queen during her visit to Liverpool this week, was lighted throughout by the electric light. The Electrical Power Storage Company's batteries were used for the purpose in the royal apartments, and a very successful effect was produced by the use of beautifully etched glass globes, the light being further subdued by light draped silk shades. The whole of the work was carried out by Messrs. Holmes and Vaudrey, of the Liverpool Electric Supply Company, Limited.

The Electric Lighting Bills.—A petition has been prepared by the Institution of Civil Engineers for presentation to the House of Lords. It recites that Bill No. 3 (Lord Houghton's) extends the time for purchase as per Clause 27 of the Electric Lighting Act, 1882, and Bill No. 2 ameliorates that clause to some extent, and states that capital is not likely to be attracted to an electric light undertaking, which must be one of development, extra capital being required as the use of the light is extended. No one would, however, be found "to embark money after the lapse of a few years, when the time of enjoyment was so much shortened." The petitioners therefore pray that Bill No. 3 may not be allowed to pass into law, but the Electric Lighting Act (1882) Amendment (No. 1) may pass into law, and that the Petition may be referred to the Committee now sitting.

The Electrical Transmission of Power.—We learn that MM. Rothschild Frères have rented very extensive offices at 13, Rue Lafayette, Paris, as head-quarters of the company formed by them for the purpose of offering the public the results of Marcel Deprez's experiments on the transmission of power by electricity. Opinion in Paris seems to be much divided as to the value of these discoveries from a practical point of view. On the one hand, we are told that for three months the receiving machines at the La Chapelle station (Chemin de fer du Nord) have been at work, and that the results of some hundreds of tests have shown work developed up to 30 and 50 H.P., representing a loss through transmission of 50 and 70 per cent. The motive power is situated at Creil, some 56

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kilometres from Paris. We understand that a very favourable report on the scientific and commercial value of these experiments has been made by a commission of 38 members selected from among the leading personages in science and finance, and formed for the purpose of conducting an exhaustive examination of the work obtained from the machines at La Chapelle. During the experiments carried out by this commission, the receiving machines developed nearly 50 H.P., which was applied to the working of large hydraulic apparatus employed in the internal service of the station, and of winches, motors, hammers, &c., altogether forming an example of electrical distribution as applied to industrial purposes. A sub-commission has been appointed to draw up a complete and detailed report upon the results of the experiments so as to accurately determine the exact power developed and the loss through transmission. As opposed to this favourable report, the opinion of many scientific men is decidedly against the practical value of these discoveries. They affirm that Mons. Marcel Deprez has approached the subject on altogether a wrong tack, and that he is completely in error when he states that the loss of power through transmission is quite independent of distance, and that better results are obtained from small conductors than from large. They say that the figures given are not to be relied on, and in any case it is doubtful whether the results of his experiments will show any improvement on those already obtained by Mons. Felix at Cermaize, and by the director of the powder manufactory at Sévran. More than a million francs have been spent in these experiments which have yet to be reduced to some practical form, and it shows considerable courage on the part of MM. Rothschild to embark so largely on an enterprise as yet practically undeveloped.

International Railway Exhibition. — An International Exhibition will take place in Paris next year, when the railway jubilee will be solemnly celebrated. This exhibition will comprise the different industrial branches concerning railways, such as engineering, mechanics, signals, locomotion, apparels for lifting, heating, lighting purpose, inter-communication, machinery, waggons for travellers and goods, models of improved railway waggon couplings and other railway appliances, building and conveyance material, furnishing, metallurgical trade, electricity, &c.

East of Scotland Engineering Association.—At the last meeting for the session of this association held last week in the Oddfellows' Hall, Edinburgh, Mr. A. C. Elliott read a paper on "Automatic Electric Railways," which gave rise to considerable discussion.

The Newest "Brush."—The *Age of Steel* has been informed that the Brush Electric Company of Cleveland, Ohio, is constructing what our contemporary incorrectly describes as the largest dynamo in the world. It will be 12 or 13 feet long, 5½ feet wide, and weigh 10 tons. The dynamo will give a current of 122,500 ampères at an E.M.F. of 2 volts. This machine will be used for the smelting of aluminum, in connection, we believe, with the Cowles electric furnace recently described and illustrated in the REVIEW. Five hundred horse-power will be required to drive it, which will be furnished by water with the aid of turbine wheels. The largest dynamo ever constructed is that designed by Mr. J. E. H. Gordon, and built by the Telegraph Construction and Maintenance Company. Mr. Gordon's enormous dynamo was illustrated and fully described in our colums for October 28th, 1882.

New Book on Electric Lighting.—Mr. A. A. Campbell Swinton has at present in the press a small book entitled "The Elementary Principles of Electric Lighting." It treats the first principles of the subject in the simplest possible language, and is intended as a primer for the use of workmen and unscientific persons, totally unacquainted with the rudiments of electrical science, and as a stepping-stone to treatises of a more advanced and elaborate nature.

The Edison-Woodhouse and Rawson Case.—At the time of our going to press the Solicitor-General (Sir Horace Davey) had commenced his opening statement for the defence in this case. He submitted that the use of a carbon conductor in a sealed glass bulb was open to the world, King having in 1845 described the use of carbon for the purpose, and Swan having used a carbon filament in a lamp which he described at Newcastle in 1878. Edison merely used a finer conductor, and this did not constitute an invention; he claimed the method of manufacture in his specification, and not the material used. The importance of high resistance was described by Lane-Fox and Prof. Tyndall before the date of Edison's specification, both pointing out that in order to procure high resistance a fine wire or filament must be used.

Listening for an Electric Shock.—At the Thames Police Court, last week, Thomas Wackett, 28, was charged with being a wandering lunatic. At two o'clock on Thursday morning Wackett was seen wandering in Grove Road, Bow. He was watched, and Constable 225 K saw him lie on the tram lines and put his ear to the line, saying he was listening for an electric shock. He had his coat off, and, in answer to the constable, he said an electric battery was in his coat and he put it off. The doctor said that the prisoner was of very weak intellect. Defendant, who made a long rambling statement, was remanded.

"Industries."—This is the title of a new Manchester journal, a specimen copy of which we have now before us. The task which the proprietors of *Industries* have resolved to undertake is the establishment of a journal which shall commend itself to all classes connected with scientific and industrial pursuits. The object aimed at in carrying out this, is to bring before engineers, electricians, chemists, manufacturers, and all actively engaged in industrial occupations, the most recent practical applications of science, and the latest developments in the chief home and foreign industries. The electrical department will, we understand, be directed by Mr. Gisbert Kapp, and we congratulate the proprietors on having made such a capital choice. The paper is in colour a light greenish-blue with the letterpress and illustrations in indigo. We shall not be surprised if after a few issues, the first of which will appear on the 2nd July, a return will be made to black and white. The style of the articles generally, brings irresistibly to our mind an esteemed contemporary, the *Mechanical World.*

French Submarine Cable Works.—M. Granet, the Minister of Posts and Telegraphs, has just completed an inspection of the Government submarine cable works at La Seyne, near Toulon. The object of his visit was to arrange for the production at these works of the various materials comprised in submarine cables, such as conductors, gutta percha, compounds, &c., which hitherto have been brought from England. At present there are only two sheathing machines at La Seyne, one for light cables and the other for heavy types. The former can turn out 3,000 metres of deep sea type, and the latter 2,000 metres of intermediates and shore ends, per diem. The improvements and additions to these works are to be on a very large scale, and are evidently instigated in consequence of a scheme, now before the French Government, for placing France in closer connection with her colonies by means of submarine cables on a very extensive system. Meanwhile M. Granet has signed a concession for submarine telegraph cables which will place certain of the colonies in more direct communication with France. The cost of these cables is estimated at about 15 millions of francs. This concession will be submitted to the Chamber when Parliament next assembles.

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Every Builder his own Electrician.—Mr. Edward Conry favoured us last week with a capital letter anent the article we published from the pen of Mr. Hamilton-Church. We trust that both the article in question and Mr. Conry's communication will meet the eye of many a builder and that some of the Transatlantic enterprise may be stirred within them. We cannot, however, do otherwise than agree with another correspondent, who takes Mr. Conry to task respecting the manufacture of the Planté form of secondary batteries.

The Royal Society.—The *conversazione* of the Royal Society was held on Wednesday evening. Some 600 to 700 guests were present, and amongst the exhibitors we noticed the names of Mr. Conrad Cooke and the Electrical Power Storage Company.

The Cable Conference.—The International Conference for the protection of submarine telegraphs held its first meeting at the Paris Foreign Office on Wednesday. It was opened by M. de Freycinet. Delegates attended from the Argentine Confederation, Austria-Hungary, Belgium, Brazil, Costa Rica, Denmark, the Dominican Republic, France, Great Britain, Greece, Guatemala, Italy, Japan, the Netherlands, Portugal, Roumania, Russia, San Salvador, Servia, Spain, Sweden and Norway, Turkey, the United States, and Uruguay. A sub-committee was appointed to examine and report on the legislation required in different countries to give effect to the Convention of March 14th, 1884. It consists of Mr. Lamb, M. Orban, M. Renault, Mr. MacLane, and Senor Coromina. On the motion of Mr. MacLane, the United State Minister, seconded by Mr. Kennedy, it was agreed that the representatives of telegraph companies shall attend the sub-committee, and make their statements before it. They will accordingly go before the sub-committee to-morrow. Mr. Pender, the Marquis of Tweeddale, and others represent many of the companies. The conference is expected to meet again next Saturday or Monday, to receive the report of the sub-committee. The telegraph companies wish to make an amendment in the convention, to relieve them from certain costs imposed by it.

The British delegates are :—Mr. Kennedy, C.B., head of the Commercial Department of the Foreign Office ; Mr. Trevor, C.B., Assistant Secretary to the Board of Trade ; and Mr. Lamb, of the Secretary's Department of the Post Office. Mr. Farnall, of the Foreign Office, will be secretary to the British delegates.

Incandescent Lamp Patents.—The first portion of our report of the law suit now going on between the litigants in the matter of incandescent lamp patents will prove interesting reading. We shall endeavour to enter as fully into this matter as we have done in previous trials in which the telephone figured as the bone of contention.

Sale of Electrical Plant.—We would remind our readers that the effects of the Consolidated Electric Company, now in liquidation, will be sold by Messrs. Wheatley Kirk, Price and Goulty, on Wednesday and Thursday next, commencing each day at 11 o'clock prompt.

Electric Locomotion.—Mr. A. J. Jarman writes again as below :—" I presume the local newspaper referred to by your correspondent, Mr. Alfred Melhuish in the last issue of the ELECTRICAL REVIEW, containing a *detailed* account of the trial of the electric locomotive of the Electric Locomotive and Power Company was the *Leyton and Leytonstone Express and Independent*. I would say that upon making a search at Somerset House I find that the name of the registered proprietor of that paper and the name of the secretary of the above company is the same, the address being the same in both cases, in all probability these reports should be taken *cum grano salis* until we have corrected reports certified by competent men."

Improvements in Telephones.—In our next issue we hope to be able to illustrate an improved telephonic receiver, designed by Mr. J. Ebel, who is already well-known to our readers in connection with submarine cable operations.

Dermatine.—A company is in course of formation to work the patents of Mr. Maximilian Zingler for the manufacture of dermatine, a substance said to be a substitute for gutta-percha, India-rubber, and leather. The prospectus states that " Insulated telegraph wires for underground work have been covered with it, and the results obtained warrant the anticipation that in this department alone a large business will be done by the company. The capacity of the material for standing high temperatures should make dermatine-covered wires especially safe and desirable for electric light leads. Specimens of wire, of a pattern suitable for underground work, have been proved to possess an insulation of over 1,000 megohms per knot after prolonged immersion in water ; it is therefore confidently believed that the company will be able to supply to the public an equally efficient and far more durable insulated wire than any now in the market, and the prices being lower than those charged for India rubber or gutta percha, it is expected that Dermatine will, to a very great extent, eventually supersede the materials now used for this and many other electrical purposes." We should like to test some of this material.

NEW COMPANIES REGISTERED.

Woodhouse and Rawson Electric Contract and Maintenance Company, Limited.—Capital : £50,000 in £10 shares. Objects : To acquire the goodwill of the contract department of Messrs. Woodhouse and Rawson, of 11, Queen Victoria Street, and also the electric installation, contract and maintenance business of the Crossley Telephone Company, Limited, so far as the same respectively relate to Lancashire, Yorkshire, and Cheshire. Signatories (with 1 share each) : *F. L. Rawson, J. H. Ward, W. L. Madgen, 11, Queen Victoria Street ; *J. F. Harrison, Rawdon Hall, near Leeds ; *C. H. Priestley, Idle, near Bradford ; A. W. Lassen, Bradford ; J. Renwick, 58, Olinda Road, Stamford Hill, N. Directing qualification : 25 shares. Remuneration : £200 per annum. Mr. Otway Edward Woodhouse is appointed a director. Registered 6th inst. by Mr. Sydney Morse, of 5, Lime Street Square. Registered office, 19, Bolton Road, Bradford.

British and Colonial Dermatine Company, Limited.—Capital : 100,000 in £5 shares. Objects : To manufacture " Dermatine," a substitute for gutta percha, for insulating, waterproofing, &c., and for such purpose to acquire the assets and property of the Dermatine Syndicate, Limited, of 7, William Street, Camberwell. The purchase consideration is £40,000, payable in cash or in cash and paid up shares. Signatories (with 1 share each) : *Sir H. C. Mance, Bedford ; M. Zingler, 16, Fenchurch Street ; *W. W. Lander, 26, Throgmorton Street ; W. C. Watson, 7, Great Winchester Street ; *C. Kuypers, Leadenhall House ; J. S. Waterfield, 7, William Street, Camberwell ; J. J. Michael, 23, St. Quintin Avenue, North Kensington. Directing qualification : 50 shares. Remuneration : £100 per annum to each director. Mr. J. H. M. Batten is appointed a director. Mr. Maximilian Zingler is appointed chemical and technical superintendent for five years, at a salary of £400 per annum. Registered 8th inst. by Messrs. Crossley and Burn, 13, Moorgate Street.

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Brilliant Incandescent Lamp Company, Limited.—Capital: £5,000 in £1 shares. Objects: To manufacture filament forming part of incandescent and other lamps, according to the process of G. Zanni. Signatories (with 1 share each): *G. Zanni (electrical engineer), 65, Gibson Square, N.; *R. Matthews, 21, City Road; *S. Baugh, 11, Canonbury Park North; D. Zanni, 59, Cloudesley Square, N.; S. Tugman, 98, Junction Road, N.; J. Lea (electrical engineer), 75, Arlington Road, Camden Town; S. Matthews, 21, City Road. Qualification for directors, other than the first: 50 shares. The remuneration of the board will be appointed by the company in general meeting. Registered 8th inst. by Mr. D. E. Chandler, 45, Finsbury Pavement.

Alfred Slatter and Company, Limited.—Capital: £10,000 in £5 shares. Objects: To take over the business of electrical engineer carried on by Mr. Alfred Slatter, trading as Alfred Slatter & Co., at Leadenhall Chambers, St. Mary Axe. Signatories (with 1 share each), Edward Quick, C.E., Telford Avenue, Streatham Hill; Charles Major, 14, Prah Road, Finsbury Park; W. Wild, Leadenhall Chambers; A. L. Craig, 16, Woodvale, Forest Hill; J. S. Sledge (electrical engineer), 6, Mervan Road; F. W. Lewis, Metropolitan Chambers, New Broad Street. Mr. Alfred Slatter is appointed sole manager, at a salary of £250 per annum. Registered 11th inst. by Mr. Wm. Wild, Leadenhall Chambers.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Locomotive and Power Company, Limited.—An agreement dated the 22nd ult. and filed on the 8th inst. provides for the issue to Mr. Mark Bean, of Leytonstone, of 54 shares of £5 each in the capital of the company, to be considered as fully paid up when the sum of £3 6s. 8d. per share has been paid thereon.

Sir Coutts Lindsay and Company, Limited (Electricians).—The first annual return of this company made up to the 30th ult. was filed on the 5th inst. The original nominal capital of the company was £7,000 in £1 shares, but by special resolutions of the company in general meeting it has been increased to £30,000 in £1 shares. 20,000 shares have been taken up and £17,247 has been paid in respect thereof, and £2,753 remains unpaid. Registered office, 135, New Bond Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Brazilian Submarine Telegraph Company, Limited.

LORD MONCK presided on Wednesday at the 25th Ordinary General Meeting of this Company, held at Cannon Street Hotel. There was but a small attendance of Shareholders.

After the formalities of reading the convening circular and minutes,

The Chairman said: I am happy to say it will not be necessary to take up much of your time in recommending the resolution, that the report be adopted, for your consideration. The report, in fact, tells you almost everything I can tell you of the working of your system. You have observed from it that your property is all in good condition—good working order; your cables are working efficiently, and we have for the last half year, and I am happy to say up to this moment, enjoyed a good share of business, your expenses having been diminished, as compared with previous half-years, by some £6,000 or £7,000. These features constitute the favourable side of the picture. But I am sorry to say that you will also observe by the return given of the income of the Company that we are not in as flourishing a state, pecuniarily, as we have been in the habit of being. Our income has diminished during the half-year which we are now considering. but there are causes in operation which we hope will cease, which will account for that. There has been an unhappy monotony in almost every meeting of a commercial character which one reads of, in which the Chairman is obliged to refer to the depressed state of trade for several years past. That still affects us. For some time it did not affect us—very curiously—for up to about a year ago our income was a growing one. But we now seem to have shared with other companies and enterprises of this kind, the effects of the depression of trade, and our income has been reduced. There is also another reason for the reduction, that is, the state of the exchanges between this country and Brazil. A great deal of our receipts, you are aware, are collected in Brazil, and, of course, are obliged to be transmitted home to England, and if the exchange is against us, of course we suffer in that way. The state of things is, however, improving. An improvement in the value of the Milrei has taken place, and has continued, I am happy to say. Therefore that cause will cease to affect our income to a certain extent. We also are suffering from a certain amount of competition on the part of the West Coast Company, which, of course, we cannot avoid. We must only meet it in the best way we can. We are engaged in negotiations which it would not be wise further to enter into, for consolidating and improving our position in Brazil, which will, to a great extent, get rid of difficulties of that kind. I do not think there is anything further in the accounts which calls for remark. You have them in your own hands, and I shall be glad to answer any questions. Meanwhile I move that the report and accounts to 31st December last be approved and adopted.

Sir Thomas Fairbairn seconded the resolution, which was adopted.

Mr. Griffiths, a shareholder, thought they had been fortunate in escaping the effects of the depression so long. He would ask whether during the last five months the falling off in the receipts had continued, and if so, if it would be likely to continue. He further asked for some information as to the meaning of the word Milreis; also what amount of debentures had been issued in respect of the West Coast Company. He had heard glowing anticipations of results described, but was not himself so sanguine. It would be satisfactory to hear a little more of their position in Brazil.

The Chairman replied: The "Milreis" is the unit of circulation in Brazil. We get our receipts from Brazil, in Milreis, and we have to turn them into £'s. sterling. That is the way in which the Exchange affects us. With regard to the West Coast Company, I think that question was fully debated at the extraordinary meeting held in January. Up to the present we have done nothing beyond proceeding with the construction of that line of telegraph, which is now being constructed; and, of course, we can tell nothing more than we have told as to the probable beneficial results. Those who are best qualified to judge, think it may be a profitable concern for us. All the traffic from that coast will, of course, pass over our lines, and any benefit derivable from it will come to us. With regard to the negociations, I am afraid I must adopt the same formula often adopted in the House of Commons, and say that it would not be in the interests of the company that I should enter more largely into the matter. These negociations are in progress, and I believe they will result in great advantage to this company. Beyond that I hope the meeting will not ask me to go on the present occasion. For the last 12 or 13 years the shareholders have trusted me and my colleagues with the management of their affairs, and I do not think they have had any reason to regret that confidence. As to the business during the last five months, it does not, I am sorry to say, show any recovery as yet.

Mr. Griffiths: I do not wish to ask any question that will hamper the directors, but what is the object of the negotiations in Brazil?

The Chairman: To consolidate and strengthen our position in Brazil.

Mr. Griffiths: But that is so very general. I must say I do not think the answers have been altogether satisfactory.

The Chairman: It is as far as I can go. Of course before any arrangement is concluded, it will have to come before the shareholders for their opinion.

Mr. Griffiths: But we as shareholders have a right even to look at the books if we choose. I think we ought to have a little more knowledge as to the future.

The Chairman: I have gone as far as I can go without violating my general duty to the shareholders generally, that of maintaining silence on a subject that should not be publicly known. (Hear, hear.) Therefore, I shall now put the resolution.

The resolution was then put and carried; as also was a vote of thanks to the chairman and directors.

Submarine Cables Trust.

ON Tuesday afternoon, at Winchester House, Old Broad Street, the 15th annual ordinary meeting of certificate holders was held under the presidency of Mr. John Pender. The report of the trustees (published in our last issue) was submitted.

The Chairman said the actual revenue of the Trust for the year ending April 15th, 1886, amounted to £18,838, as against £23,493 for 1885. The decrease of revenue, as explained in the report, had been caused entirely by the diminished dividends paid by the Anglo-American Company, in consequence of the Commercial Cable Company having forced the Atlantic companies to reduce

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the tariff from 2s. to 1s. 8d. per word. As it requires £21,635 to cover our coupons and expenses, it is evident that but for the large balance brought into the accounts from the previous year, and the accidental circumstance of our having five quarterly dividends—through the Eastern Extension Company—to deal with, we should not have been able to pay our coupons in full. Practically, we began our last financial year with a balance of £4,937, and we carry forward £2,140. He hoped before they met again they would be working at remunerative rates, and be enabled to pay our coupons in full. He hoped that good sense would prevail, and that some alteration in the present tariff of the American Telegraph Company would be made, as he was sure the present rate could not be permanent, and would not pay. With these remarks he moved that the report of the trustees now submitted be approved.

Sir Daniel Gooch seconded the motion, which was put and carried unanimously.

The re-election of auditors, with remuneration of £25 each, was moved by Mr. Ford and adopted.

A vote of thanks to the chairman and to the co-trustees was agreed to, with an expression of the hope that the chairman's forebodings in reference to the dividends would not be realised.

The Chairman, in replying, said that the motive of himself and the trustees was, of course, to make money, and he trusted that sound business principles would prevail, and that they would be able to pay their coupons in full. They sincerely trusted that might be so.

The meeting then separated.

Great Northern Telegraph Company of Copenhagen.

At the general meeting of this company, held at Copenhagen on the 21st April, F. Zahle, Esq., presided.

The Chairman, C. F. Tietgen, Esq., addressed the meeting with regard to the general business of the company during the working year of 1885, and referring to the state of the company's cables said, that although the directors that evening would have the pleasure to report satisfactorily about the results of the year, there was not much to say under this heading. The usual interruptions of the cables, which could not be avoided, had again occurred; but having in themselves at no time been of an alarming nature, the repairs had, thanks to the efficiency of the company's two repairing steamers, the *H. C. Orsted* and the *Store Nordiske*, stationed respectively in Europe and in the far East, and thanks to the efforts of the company's excellent staff, been most speedily effected. During such interruptions the traffic of the company had in no way suffered, as the duplication system of the company had provided the means for supplying a ready outlet for the traffic which had originally been intended for the line interrupted for the time being. The only drawback of these repairs had been, as must always periodically occur, that the stock of spare cable used for repairs had to be replenished, and the company had therefore incurred an expense by ordering a new supply, the comparatively small cost of which had been included in the amount shown in the balance sheet as deducted from the reserve fund. The northern land line, passing through Siberia and connecting the company's European cable net with their lines in the far East, had in May, 1885, been interrupted for a fortnight, in consequence of inundations caused by the breaking up of the ice. These interruptions had in late years been very unusual, and the strenuous efforts which are being made to prevent such occurrences would guarantee against them in future. The traffic receipts had been highly satisfactory, and exceeded—theoretically, at least—the receipts in the prosperous year of 1884. Practically this excess, and more, even, had, however, unfortunately been absorbed by the loss of exchange on remittances. As the shareholders would be aware, the company collected their rates in the far East in Mexican dollars, and whilst ten years ago about 4s. 3d. could be remitted for a dollar, the company now barely received 3s. 4d. Considering that more than half a million of dollars was annually remitted in this manner, a heavy loss would therefore naturally result, and the large amount figuring on the debit side of the profit and loss account was thus explained. The great event of the year had been the International Telegraph Conference, which had been assembled at Berlin from the 10th August to the 17th September. Without entering into the details of different measures which had been laid before the conference, he would at once refer to the proposal of the German Administration with regard to the introduction of a uniform International Telegraph Tariff between any two countries within the limits of Europe—a project which had already been before the previous conference held in London in 1879. Although the measure did not pass in its entirety, the tendency of the original proposition had been so strong that in the result serious tariff reductions were adopted, and notably as regarded the telegraph correspondence between the more distant countries in Europe. It would naturally follow that in such circumstances our company, whose cables carry a very considerable part of the European and extra-European traffic, would have to be prepared to suffer a loss in consequence of the reductions passed at Berlin. To give examples: A message of 12 words (which our experience now showed us to be a fair average of messages transmitted over the company's lines) from Great Britain to Russia now costs 9s., whereas after the 1st July it would only cost 6s. 6d. The same with regard to China, for which country the rate from this country now is 8s. 4d. per word, whilst after the 1st July next it will only be 7s. 1d., and as the greatest proportion of these rates accrued to the company we would consequently have to bear the greatest part of the proportion of the reductions. These reductions would, however, no doubt have the effect of gradually increasing the traffic, and thus, to a certain extent, compensate for the losses which the company would suffer. But, then again, such an increase of traffic would mean eventual increase of staff and of telegraph lines, and the company would therefore have to be prepared sooner or later to resort to the reserve fund. For this reason the directors had thought it right to propose once more to increase that fund in the same exceptional manner as in former years. In accordance with conventions concluded with Russia and Sweden, the company had already now obtained, free of any extra expense, a reserve line between St. Petersburg and Nystad, in Finland, and another in Sweden between Grislehamm and Gothenburg. These two lines would be connected by the cable which had been laid by the company between Sweden and Finland in 1883, and thus constitute a complete and direct line from St. Petersburg to Gothenburg, which would be of great advantage in the transmission of the traffic between Russia on the one side and Great Britain and France on the other side. At the same time, he would mention that the company was now going to introduce instruments with certain improvements, which, after a fair trial, had shown that by their employment greater speed of transmission could be ensured within the carrying capacity of the cables. The position of the company would thus be that they would be enabled to meet all requirements in case a considerable increase of the traffic resulted. But, unfortunately, the effect of the continued general stagnation of trade, industries, and navigation, which as regards the company's revenue is no longer counterbalanced by the effect of political and military movements in the far East, had already been felt in the amounts of the receipts as shown by the monthly traffic returns published since the beginning of this year. What with the falling off in earnings, and what with that which after the 1st July next would follow from the reduction of the rates, it could be foreseen that the company's future income, and particularly that of the present year, would be considerably lower than that of previous years. Thanks to the further addition to the reserve fund, and to several other measures taken during previous good years, it could, however, be hoped that the exceptional circumstances referred to would not tend to diminish the dividend hitherto paid to the shareholders in any sensible degree. The feverish activity which the political events had called forth some years ago with regard to the development of the telegraph net in the interior of China had somewhat abated after the conclusion of the peace between France and China. The fact, however, remained that the telegraph had become a positive necessity for the Chinese, and no fears need therefore be entertained that further developments would be arrested. During the year several lines had been established, of which one of the most important was that which connected Seoul, the capital of Corea, with the Chinese telegraph system. This line, which had been constructed by the company's engineers, of whom several had entered permanently into the Chinese service, would shortly be extended from Seoul to Fusan, the Japanese colony on the South Coast of Corea, the landing place of the cable connecting Corea with Japan proper, which the company had laid in 1883. The company's instrument workshop at Copenhagen had been well employed, and had latterly received important orders for instruments. The balance sheet, which had been in the hands of the shareholders for some time past, had shown that after all the general charges, as well as the ordinary charges for interest and amortisation of debentures, and the payment of the usual 5 per cent. interim dividend during the past year, had been provided for, there remained an amount of £133,699 13s. 6d., which the directors submitted to the meeting to deal with as follows:—£45,833 6s. 8d. to be divided amongst the the shareholders as an extra dividend of three per cent. (making the dividend for the year, including the interims already paid, 8 per cent.); £2,777 15s. 7d. to be allotted to the pension fund for the staff; £55,555 11s. 1d. to be added to the reserve and renewal fund; and £29,533 0s. 2d. to be carried forward to next year's account.

Without discussion the propositions of the directors were unanimously adopted, the accounts were passed, and the usual discharge was given to the directors.

L. P. Holmblad, Esq., the retiring director, was unanimously re-elected.

A. Berner, Esq., and Aug. Garde, Esq., were likewise unanimously re-elected as shareholders' auditors.

The West India and Panama Telegraph Company, Limited.—We are informed that at a meeting of the directors held on Wednesday last, it was decided to place £2,000 to reserve, and to recommend to the shareholders at the approaching meeting that a dividend of 6s. per share be declared on account of arrears of dividend on the first preference shaers.

Consolidated Construction and Maintenance Company, Limited.—The directors have resolved to recommend, subject to final audit, that a further dividend of 2½ per cent. be paid, making 5 per cent. for the year.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 7th were £1,749, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

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PROCEEDINGS OF SOCIETIES.

Royal Society, March 25th.

[ABSTRACT.]

"On the Changes produced by Magnetisation in the Length of Iron Wires under Tension." By SHELFORD BIDWELL, M.A., LL.B. Communicated by Prof. F. GUTHRIE, F.R.S.

In a paper communicated to the Royal Society about a year ago, the author discussed the results of certain experiments made by Joule in relation to the effects of magnetism upon the dimensions of iron and steel bars.

It is well known that the length of an iron rod is in general slightly increased by magnetisation. Joule enunciated the law that the elongation is proportional in a given bar to the square of the magnetic intensity, and that it ceases to increase after the iron is fully saturated. The author's experiments, made with a greater range of magnetising forces and with thinner rods than those used by Joule, showed that if the magnetising current were gradually increased after the so-called saturation point of the iron had been reached, the elongation, instead of remaining at a maximum, was diminished, until, when the current had attained a certain strength, the original length of the rod was unaltered, and if this strength were exceeded, actual *retraction* was produced.

Joule also found that when the experiment was performed upon an iron wire stretched by a weight, the magnetic extension was in all cases diminished, and if the weight were considerable, magnetisation caused retraction instead of elongation. From these facts he appears to have formed the conclusion that, under a certain critical tension (differing for different specimens of iron, but independent of the magnetising force), magnetisation would produce no effect whatever upon the dimensions of the wire. In one of his experiments a certain iron wire loaded with a weight of 408 lbs. was found to be slightly elongated when magnetised; the weight was then increased to 740 lbs., with the result that magnetisation was accompanied by a slight retraction. In both cases the magnetising currents varied over a considerable range, and the smaller ones were without any visible effect. Commenting upon these results, Joule conjectured that "with a tension of about 600 lbs. (which number is roughly the mean of 408 and 740) the effect on the dimensions of the wire would cease altogether in the limits of the electric currents employed in the above experiments."

In reference to this surmise the author in his paper of last year expressed his belief that, if Joule had actually made the experiment, he would have found that the length of the wire was increased by a weak current, that a current of medium strength would have had no effect whatever, and that one of his stronger currents would have caused the wire to retract. He had, in fact, reason to believe that the effect of tension was to diminish the "critical magnetising force" (which produces maximum elongation), so that the retraction which is found to occur in all iron rods when a sufficient magnetising force is employed, is observed with smaller magnetising currents when the rod is stretched than when it is free, but want of suitable apparatus prevented him from submitting this idea to the test of direct experiment.

He has lately modified the instrument, which was described in his former paper, in such a manner that it can be used for observing the effects of magnetisation upon rods and wires under traction, and the results of a series of experiments made with it are presented in a synoptical form in the subjoined table. Four specimens of iron were used. The first was a wire of commercial iron, 1·2 mm. in diameter, which had been softened by heating in a gas flame; the second was a strip of annealed charcoal iron, 5·5 mm. wide and 0·55 mm. thick, its sectional area being about 3 mm.; the third was a piece of hard unannealed wire, 2·6 mm. in diameter; and the last was a wire of very pure soft iron, 3·25 mm. in diameter, which had been carefully annealed. These were successively fixed in the apparatus, and loaded with weights varying from 3 lbs. to 14 lbs. While under the influence of each load, four observations were made in the case of each wire:—(1) A determination was attempted of the smallest magnetising current which sensibly affected the length of the wire in the direction of elongation or retraction. (2) The current producing *maximum* elongation (if any) and the extent of such maximum elongation were found. (3) A determination was made of the critical current which was without effect upon the original length of the wire, *i.e.*, the current of such strength that a weaker one would cause elongation and a stronger one retraction. (4) The retraction produced by a fixed current of 1·6 ampère was measured.

The figures recorded in the table disclose the following facts:—

(1) The effects produced by magnetisation upon the length of an iron wire stretched by a weight are in general of the same character as those which have been shown in the former paper to occur in the case of a free iron rod. Under the influence of a gradually increasing magnetising force such a wire is at first elongated (unless the load be very great), then it returns to its original length, and finally it contracts.

(2) The maximum elongation diminishes as the load increases according to a law which seems to vary with different qualities of iron. If the ratio of the weight to the sectional area of the wire exceeds a certain limit, the maximum elongation (if any) is so small that the instrument fails to detect it.

(3) The retraction due to a given magnetising force is greater with heavy than with light loads.

(4) Both maximum elongation and neutrality (*i.e.* absence of both elongation and retraction) occur with smaller magnetising currents when the load is heavy than when it is light; retraction, therefore, begins at an earlier stage. Thus the anticipation expressed in the author's former paper is justified.

(5) The phenomena, both of elongation and of retraction are, as might be expected, greater for thin than for thick wires, and for soft than for hard iron.

Physical Society, May 8th, 1886.

Prof. H. McLEOD, F.R.S., Vice-President, in the Chair.

Mr. W. A. PRICE was elected a member of the society. The following communications were read.

"On a Modified form of Wheatstone's Rheostat," by Mr. SHELFORD BIDWELL. A wire is coiled upon a non-conducting cylinder, as in the ordinary forms of rheostats, one end of the wire being in contact with the brass axle of the cylinder. A screw is cut upon the axle, the pitch being equal to the distance between the consecutive turns of the wire, and this, working in a fixed nut, causes the whole cylinder to travel in the direction of its axis. A fixed spring bears upon the wire at a convenient point, and by the travelling motion of the cylinder this point of contact remains fixed in space, and the effect of turning the cylinder is to introduce more or less resistance between the spring and the brass axle. Binding screws on the base of the instrument are in contact with the nut and the bearing spring. Though this arrangement has several obvious advantages over the usual forms, Mr. Bidwell does not recommend it in cases where it is required to introduce a known resistance, but where it is important to adjust a resistance to a nicety or to cause a continuous variation it is of great use.

Prof. PERRY, remarking upon the importance of being able to vary a resistance gradually, described an instrument he had used with advantage. A number of plates of gas carbon are placed between two parallel copper plates, one of which is fixed and the other adjustable by a screw; by applying pressure by means of the screw, the resistance between the plates can be varied uniformly and regularly from 2 to 10 ohms, beyond which point the increase is very rapid.

"On a Theorem Relating to Curved Diffraction Gratings," by Mr. WALTER BAILY. In a paper read before the society in January, 1883, the author showed that if a plane be taken perpen-

	Commercial iron wire, diam. 1·2 mm.				Charcoal iron strip, section 3 mm.				Hard wire, diam. 2·6 mm.		Soft wire, diam. 3·25 mm.		
Stretching load	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	14 lbs.	3 lbs.	14 lbs.	
Smallest current producing sensible elongation	0·043	0·064	0·084	...	0·033	0·020	0·029	0·064	0·12	0·15	0·064	0·033	Ampères.
Current producing maximum elongation	0·49	0·39	0·23	...	0·44	0·33	0·27	0·15	0·70	0·58	0·70	0·58	Ampères.
Current by which original length is unaffected	0·99	0·73	0·47	0·23	1·30	0·99	0·77	0·53	0·99	0·94	1·24	1·09	Ampères.
Maximum elongation in scale divisions	2	1·5	0·5	...	10	6	4	1	2·5	2·5	6·5	4·5	Scale divisions
Retraction with current of 1·6 ampère	6	9·5	11	11	9	15	18	20	11	11	8	11	Scale divisions

The magnetic field at the centre of the coil = current × 92.
One scale division = one five-millionth part of the length of the wire.

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dicular to the lines of a curved diffraction grating, and a normal to the grating be taken as the initial line, then the equation

$$\frac{\cos.^2 \theta}{r} = \frac{\cos. \theta}{c} + \frac{1}{d},$$

in which c is the radius of curvature of the grating, and d is an arbitrary constant, gives a curve having the property that if a point of light be placed anywhere upon it, the curve is the locus of the foci of all diffracted rays whether reflected or transmitted. In the present investigation d is supposed to be greater than c, which allows of the source of light being at infinity. The points where the curve given by the above equation cuts the normal are called the normal foci. There are two of these, one relating to the reflected and the other to the transmitted light, the grating being supposed to consist of a number of opaque lines in space. It is then shown that if the grating be supposed to turn about the line in it intersecting the initial line, the normal foci will trace out two parabolas whose common focus is the origin, and common latus rectum is equal to the diameter of curvature of the grating, the parabola for reflected light being convex to the source of light, and that for transmitted light, concave.

"On Some Thermo-dynamical Relations," part IV., by Prof. W. RAMSAY and Dr. SYDNEY YOUNG. The first part of this communication deals with Profs. Ayrton's and Perry's criticisms upon the previous papers by the authors upon this subject. In the second part a brief review is given by the various attempts that have been made to represent the pressure of a saturated vapour as a function of the temperature.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

4841. "A system of photo-telegraphy." W. GEMMILL. Dated April 20. 6d. The object of the system is to connect a selenium-celled circuit with a separately supplied one lighting an electric lamp so that when light or shadow falls on the selenium cell the light of the lamp flashes out or becomes more or less extinguished as the case may be, and further to vary the illumination of the lamp with the degree of light falling on the selenium, so as to make the lamp available for photo-telegraphy or the transmission of photo-telegrams or photautographs by the ordinary postal wires.

4993. "Improvements in the mode of and means for lighting houses and other structures by electricity." T. TAYLER SMITH. Dated April 22. 8d. Consists in the use of a cable, band or rope of any suitable flexible material and preferably of an ornamental appearance, enclosing within it suitably insulated electrical conductors, and fitted with concealed terminal sockets at regular or suitable intervals of say a foot, adapted to receive the terminals of detachable incandescent lamps or incandescent lamp supports.

5361. "An improved electro-medical apparatus." A. T. KING. Dated April 30. 8d. Relates to portable apparatus used for administering a current of electricity of any desired strength for medical purposes, and it has for its object an improved method of constructing and arranging the several parts of such apparatus by which great simplicity of adjustment and arrangement are attained, with fineness and evenness of the electric current produced, easy graduation of the power and strength of the current, and a wide range of character of the effects produced.

5379. "Improvements in operating electric railway trains or vehicles." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated May 1. 8d. Consists in changing the electro-dynamic motor which receives current from the line and propels the train, into a dynamo-electric generator receiving energy from the momentum of the train and giving current to the line, and under perfect control to vary the braking power.

5404. "Improvements in electrical train signalling apparatus." A. M. CLARK. (Communicated from abroad by E. J. J. de Baillehache, of Paris.) Dated May 1. 11d. Relates to a system of automatic electric train signalling for railways and steam or other tramways whereby the train is caused to signal its whereabouts to the station. This is effected by insulating one or more sections of rail and connecting the same with a line wire, so that when the train passes over this insulated section, the circuit will be closed between the insulated and uninsulated rails by the wheels of the train.

5420. "A combined electric bell push and incandescent lamp holder and switch." C. K. FALKENSTEIN. Dated May 2. 8d. Consists, preferably, of an elongated pear-shaped holder or handle, made hollow to permit of the passage of the wires to the several terminals contained therein, and having at its lower, or pendent, end a lens of suitable configuration, and so placed as to permit of a small incandescent electric lamp being mounted in the handle in proper position having regard to the lens used. Near the upper end of the handle, or at any other convenient part of it, a suitable projection serves, when depressed to complete, by means of suitable contact pieces, the bell circuit, while the circuit of the lamp is completed as required by a similar projection and contact making devices or by partly rotating the lower, or any other convenient part of the handle, contact in the latter case being made in any well known manner.

5547. "Improvements in telegraph cables, chains or conductors for submarine and other purposes, and in means for connecting such cables, chains, or conductors together, and to movable objects." R. M. LOWNE. Dated May 5. 8d. The inventor employs a cable containing a core of any convenient number of insulated conductors; over this core he employs a sheathing of any convenient number of metallic wires laid around the core so as to form a twist which preferably should entirely cover the core; around this sheathing he fixes at intervals, preferably by solder, metallic bands formed preferably of wire; the object of the bands is to prevent the wire sheathing from untwisting and lengthening when the cable is subjected to strain. Where a cable or conductor is required to be attached to a movable object he employs a universal joint constructed in such a manner as to take all strain off the electrical conductor or conductors at the movable part or parts of the joint.

5847. "An improved adjustable pendant or support for electric lamps." A. E. JONES. Dated May 12. 8d. Consists of a tubular telescopic rod or support terminating below in a lamp or lamp socket, and above in a metal cup or hemisphere fitted within a metal case of hemispherical form open at the bottom and adapted to be secured by its upper part to the ceiling. The metal cup or hemisphere is provided with a central tubular stem extending above the level of its rim and terminating in an insulated metal button or head of rounded form or cup shape against which a piston or plunger of correspondingly rounded form, or it might be a link or thrust rod, is tightly pressed by a powerful spring mounted centrally within the case. The metal cup and the lower part of the case in which it is fitted constitute a ball and socket joint, the parts of which are so proportioned and so tightly forced together that the friction of contact is sufficient to hold the telescopic rod, extending from the metal cup, rigidly in any position to which it may be moved. The insulated button at the top of the central stem of the metal cup is connected by a wire with one terminal, and the cup itself is in electrical connection with the other terminal.

6088. "Improvements in galvanic batteries." E. B. BURR. Dated May 18. 8d. Consists in so arranging the cells that they shall be connected so as to allow the liquid to flow from a reservoir on the top of the battery through each cell into a similar reservoir at the bottom of the battery. These reservoirs are made to be interchangeable, so that when the one at the top of the battery has emptied itself it can be replaced by the one at the bottom which will then be full.

6305. "Improvements in electric guns." J. C. MEWBURN. (Communicated from abroad by the American Electric Arms and Ammunition Company, of New York.) Dated May 22. 11d. The generic feature of the present invention consists of a movable electrode working through or upon a movable part of the gun, which part is movable to permit the insertion of the cartridge, and acts as a breech block or stopper, or to support or lock the breech block, and the electrode moving with such part but having itself an independent movement relatively thereto in order to bring it into contact with the cartridge to close the circuit thereto and fire the gun.

6365. "Improvements in telegraphic apparatus." R. K. BOYLE. Dated May 23. 11d. Relates to telegraphic apparatus and is chiefly designed to provide for enabling two or more messages to be transmitted simultaneously, or approximately so, through the same line-wire by different operators working independently of each other and irrespective of the time or speed of transmission. The improved apparatus is so constructed that each message sent will be received clearly and distinctly by sounds or other signals; and the armature or recording part of the receiving instrument is not limited in its movement, but can nevertheless make the proper impression in its to-and-fro movement, it will therefore adjust itself according to the action of the varying conditions of the weather upon the electric current in the line-wire.

8049. "Improvements in the feed regulating mechanism of electric arc lamps." C. F. COOKE. Dated July 2. 8d. Consists essentially of a specially sensitive method of liberating the brake wheel of the lamp and so allowing the carbons to approach as soon as the arc grows appreciably longer than is normal.

8675. "Electric telephonic apparatus." W. BLENHEIM. Dated July 18. 8d. The receiving portion consists of a U shape piece of iron rod with a coil of wire wound on the centre portion only. Over this and extending to the ends of the rod is a secondary coil of fine wire, the ends of the U are brought near an iron armature fixed to the centre of a membrane. The transmitting portion consists of a piece of carbon or other material carried by a yielding support to allow of a piston like motion, fixed near its edge is two metal pins, these pins are connected by a mital bar, supported at its centre on a knife edge end of a lever, which is weighted at the opposite end to put pressure on the contact pins. A battery, the pins in transmitter, and primary coil formes one circuit, the outer or secondary coil is connected to the line.

11121. "Improvements in apparatus for supporting or carrying and connecting the wires of acoustic telephone circuits." G. L. ANDERS. Dated September 18. 8d. The inventor provides at each place where the wire is to be supported or its angle changed a light pulley having a groove in its periphery to receive the wire. Between the body of the pulley and its axis is placed a yielding material, preferably a piece of pure soft rubber tubing; the axis of the pulley is supported in a suitable carrier which in turn may be mounted upon a centre carried by a bracket or other suitable fixed support so that the pulley can be turned to suit any desired angle.

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to the framework of the lamp, while a little within the pivots of this lever the lever itself carries, by means of pivots carried thereby, a spindle on which are mounted a pinion and a ratchet wheel, the two together not being able to rotate in one direction without driving round a spur wheel which is mounted on the same spindle. The rack or carbon carrier has teeth cut in that side which comes against the before-mentioned pinion, the rack and pinion being thus in gear. The before-mentioned spur wheel gears into a second pinon upon the axis carrying the second wheel of a train of wheels, the second axis being mounted on bearings carried by the fixed framework of the lamp.

13607. "Improvements in telephonic receivers and transmitters." C. A. GISBORNE. (Communicated from abroad by F. N. Gisborne, and D. H. Keeley, of Canada). Dated November 9. 8d. In receivers constructed according to this invention two or more magnets are arranged upon the opposite sides of a vibratory diaphragm, preferably of iron, in such manner that greatly increased vibrations of the diaphragm are obtainable by alternate currents of electricity flowing through small helices of wire encircling the respective and similar poles of the magnets. In transmitters constructed according to this invention gravity multiple microphonic contacts are so arranged that their movements are equal and simultaneous when agitated or compressed by the vibrations of the diaphragm against which they rest or with which they are connected.

14741. "An improved duplex cut-out for electric circuits." R. M. BAILY, Jun., and A. GRUNDY. Dated December 1. 8d. Consists of a combination of a hand switch and two cut-outs, one of which can be substituted for the other in case of damage.

15040. "An improved voltaic battery." S. W. MAQUAY. Dated December 8. 8d. The positive element is composed preferably of two parts of lead and ninety-eight parts of commercial zinc, and either cast into rods or plates, or rolled out and used in any convenient shape. When the plates or rods are formed in the shape intended to be used they are coated with mercury, and submitted to heat in an oven of about 100° Fahr., and again coated and again heated, until the mercury is intimately mixed with each particle of the alloy. For the negative element, any convenient one is used, such as carbon, platinum, &c., either in plates or any other form, but a portion of such plates or rods is dipped into liquid sulphur, so that one-eighth of the plate or rod be covered with a film of sulphur, or broken granules of the sulphur are placed in the cell along with the plates, in about the same proportion, that is to say, that the surface of the sulphur granules will be about one-eighth the surface of the plates. The solution used for the outer cells is one part of sulphuric acid of common strength to twenty parts of water, or a solution of common salt.

CORRESPONDENCE.

Secondary Battery Patents.

Would you kindly inform me through the medium of your important columns if you are able to state whether there is any such "blanket" patent in America relating to secondary batteries as there is supposed to exist in this country in relation to telephone transmitters. I have recently heard it contended by some interested persons that the Faure U.S.A. patent covers not only what is said to be a most important feature, viz., the mechanical spreading of the paste, but also such principles as to preclude the possibility of any like invention being successfully perfected or used without infringing it. And against this expressed opinion I am in possession of a written one from a late Commissioner of Patents in Washington, affirming that ———'s patent and Faure's patent having been carefully examined by him, possess distinct features, and that the one is not an infringement of the other.

G. B.

May 10*th*.

[We can hardly answer our correspondent's query authoritatively, but we have no doubt that there are those amongst our readers who can do so. So far as the U.S.A. patents are concerned, we believe that M. Faure acknowledged at the outset the existence of secondary batteries prior to his invention. Therefore the fundamental idea of storing electrical energy being old, and means for that end having been devised and used, subsequent inventors could only improve on such means, unless an entirely new departure were made. A substantial difference from the first means employed is enough to warrant the grant of a second patent for the particular means. Faure invented "an electrode consisting of a support, coated on one or more faces with an active layer of absorptive substance . . . capable of receiving and discharging electricity, as stated." The support mentioned is a leaden plate similar to the one invented and used by Planté. Upon this plate he placed the coating of absorptive material, such as described, and encased the plate in a sack or envelope of porous material.

Now if we imagine an inventor, Mr. X, taking a step forward and dispensing with such a plate altogether, and making the electrode entirely of absorptive material, then, although the two electrodes perform the same office, that of Mr. X, say, being the more efficient, there is no interference between the two, and, consequently, no infringement of Fauré's patent in operating and using such a modification as that of Mr. X.

The only thing used in common by Mr. X and Faure is the absorptive or active material, and this we believe Fauré does not claim specifically in the U.S.A. patent, probably because he did not consider himself entitled to it. We shall be glad to publish any trustworthy opinions on a matter which is becoming more and more important.—EDS. ELEC. REV.]

"An Unexplored Field in Electric Lighting."

Your correspondent, Mr. Edward Conry, in the course of his remarks under the above heading, suggests the employment of accumulators formed by the original Planté method. May I ask Mr. Conry if he has ever made a successful working battery by that process? My experience is that unless the lead plates have been previously prepared the process of reversing cannot be made to yield satisfactory results.

It is true that at first reversing does increase the capacity of a cell; but if continued beyond a certain point it will be found that the peroxide of lead will become detached from the plates, instead of being reduced to spongy lead.

It would be far safer to procure the cells from a responsible firm than to trust to the productions of country carpenters and plumbers.

At the same time, it would be interesting to know if unprepared or home made plates have ever been successfully employed.

R. F. Y.

May 11*th*, 1886.

Matters Telephonic in America.

As it may be possible that some of your numerous readers on your side of the great Atlantic ferry may take some little interest in matters telephonic of this side, I send you extracts from newspapers touching an investigation by a committee appointed by Congress regarding the allegations brought against the Attorney-General. This committee sits four or five hours every day, and its investigations have taken a range so wide that any person who has ever said "telephone" can appear before the committee and testify.

I send you the entire examination of the Attorney-General under oath, so that you may be able to confirm what I now write thereon, and that is, that not a shadow of even a suspicion of improper conduct rests upon the Attorney-General. His statements were confirmed by several other witnesses, whose evidence I also send you.

I send you the evidence of Mr. Forbes, President of the American Bell Company. He stated that the capital stock of companies licensed by his company was about $50,000,000, of which his company held $22,000,000. Last year the company paid a dividend of 16 per cent. on its capital, of which only $3,000,000 was ever paid in cash to that company.

Prof. Bell testified that in 1874 he sold two-thirds of all his future inventions to G. G. Hubbard, whose daughter Bell subsequently married, and to a Mr.

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Saunders; the terms of the sale were that these two were to contribute all of the monies necessary to further experimentation, and defray expenses of taking out patents and of litigation. Bell stated that when the American Bell Company was formed he received $1,000,000 in shares of the company, and Hubbard and Saunders each a like amount. Bell transferred all his shares, save one, to his wife. Hubbard, Bell's father-in-law, testified that the amount he and Saunders paid out under the agreement with Bell was about $60,000, so that for that sum he and Saunders received each $1,000,000. One of the newspaper slips I enclose shows that some of our *free* and *independent* newspapers are not averse to receiving a little filthy lucre for their services.

The suit of the United States *v.* Bell and others will be called for trial about May 1st, and the counsel for Bell will demur to the jurisdiction of the Court, also to the right of the Government to institute such a suit—see extract enclosed.

I have read the judgment of Justice North in the case of the U. T. Co. *v.* Bassano and Slater, and it brought to my mind the wise judgments of Dogberry.

W. C. Barney.

McPherson House, Washington,
April 30th.

Sabine v. White.

I hope you will allow me to correct an error I made in my previous letter to you, and thereby do an act of justice to Mr. J. G. White in America.

In my previous letter I wrote as if the late Robert Sabine had preceded Mr. White in the same line of thought about the covering of electric wires, but in doing so, I have erred. Mr. Sabine made two tables for currents from 5 to 90, and from 100 to a 1,000 ampéres for conductors of bright copper exposed to the air. These tables were first published in the ELECTRICAL REVIEW of January 6th, 1883, and reprinted in the 5th of May number of the same year. At the end of the latter publication of the tables is appended this note: "When the conductor is covered with India-rubber, the rise of temperature will be about 25 per cent. less than the values indicated above." This note implies that to cover a wire, carrying a current of electricity, is a means whereby the wire may be kept cool, and as this result is in accordance with the results of Mr. White's experiments, I too readily adopted the conclusion, that Mr. Sabine had made experiments which led him to write the above note: but on a more careful examination of his published writings, I find that the note is a contradiction to all his other writings, and there is no evidence whatever in them to show that he had made experiments with covered and uncovered wires, such as Mr. White has made. That Mr. Sabine, prior to his making out the said tables, did not make experiments on covered and uncovered wires, is manifest from his own declaration, that the tables "are only tentative, and do not pretend to be strictly exact." In Mr. Sabine's paper, including the tables as first published on January 6th, 1883, he enters into theoretical statements about the effect of covering wires, and sums up his opinion in these words: "The elevation of the temperature of any [electric light] lead is proportional to the obstruction which the insulator offers to the escape of the heat generated in it." Now this opinion of Mr. Sabine is overturned and shown to be untrue by the results of Mr. White's new experiments, as published by Prof. Anthony in an American contemporary, and quoted on page 356 of this volume of the ELECTRICAL REVIEW.

James Johnstone.

8, Mercheston Park, Edinburgh,
May 10th, 1886.

[Mr. Johnstone might have spared us the trouble of again engaging him in a controversy. His previous letter, in so far as the late Robert Sabine is concerned, needs no correction. He *did* experiment on the subject under discussion; we were enabled to obtain a full knowledge of his work during its progress, and to occasionally assist him; and the note and opinion to which our correspondent refers not only do *not* contradict, but *verify* his other writings.

The results of his labours in this direction are, we fear, like much other valuable matter, lost to the world; but the following extract from his paper of January 6th, 1883, will be sufficient to show anyone, Mr. Johnstone perhaps excepted, that Robert Sabine had studied the question of covered *v.* uncovered electric light conductors to some purpose.

"While at work, the tendency of all light leads is to get warmer. How much warmer depends upon a balance between two things, viz., the heat generated by the current, and the facility with which this heat can *escape into and through the insulating covering.* This heat is an item of waste which cannot be wholly avoided, although it may be reduced to a minimum. If the insulating covering were as efficient an insulator for heat as for electricity, no covered wire could escape becoming, in time, when in use, incandescent. But happily those materials which are chosen in practice for electrical insulators are, as a rule, *not good heat insulators.*

"Air and glass—two of the best electrical insulators—are *very indifferent heat insulators.* Vulcanite—an excellent electrical insulator—is, when thin, *highly diathermanous.* India-rubber—the material most generally used for insulating electric light leads—*stands only second in diathermancy* to vulcanite—*a property, by virtue of which the heat generated by the current, instead of being bottled up and accumulating to the detriment of the system, is easily passed through the insulating covering and liberated.*"

We have italicised portions of the above extract, for it is evident to us that notwithstanding Mr. Johnstone's careful examination of Sabine's writings, he must have overlooked these points, or perhaps he has made himself wilfully blind to them. In conclusion we have only to add that we must decline to publish anything further on this matter.—EDS. ELEC. REV.]

Incandescent Lamp Making.

Can any reader of the ELECTRICAL REVIEW inform me if the whole process of incandescent lamp making has ever been published; and if so, where and when?

Also which is the most reliable direct-reading voltmeter to use when the E.M.F. has to be measured about 150 times per day of 10 hours. The instrument cannot be kept on continuously, as it is required for taking the E.M.F. of lamps when measuring the C.P. in the photometer; and both Cardew's and Ayrton and Perry's voltmeters, I find, are not at all suitable.

In the former the needle does not return to zero quick enough for my purpose, and the latter requires tapping at each reading; and then, I find, it must be recalibrated too often for practical use.

Very Anxious.

Ozone and other GAS.

In common with every reader of your journal with whom we are acquainted, we for some time looked forward to the perusal of certain effusions appearing in your Correspondence columns as a weekly recreation. It has, however, been suggested that the wearing threadbare of the one or two comic ideas may possibly indicate that these fearful and wondrous "facts" and "proofs" (?) are to be looked at in a serious light. The bare possibility of such an idea has struck consternation into many a manly breast; and we feel constrained to ask whether it may not be advisable to label such matter in the business-like way of the German papers, "Humoristich."

A. and B.

May 10th, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—NO. 444.

INCANDESCENT LAMP PATENTS.

MR. JUSTICE BUTT has done what Mr. Justice North declined to do: a question of degree having arisen in an action relating to a patented invention, he has boldly placed the limitation which he conceived the patentee intended upon certain words in the specification,—not a precise limitation, but one sufficient for the purposes of the action. In the memorable telephone patent case, "United Telephone Company *v.* Bassano," Mr. Justice North, notwithstanding that no reasonable man could for a moment suppose that Edison intended to claim as part of his invention any substance, of whatever form or magnitude, which would respond to the vibrations of the air and thus transmit sound—and, according to scientific evidence, there is scarcely any substance which will not so act—held that "diaphragm," as used in Edison's specification, covered the use of the wooden framework of the Bassano telephone. It was a question of degree only, and, although Edison's diaphragm had a definite form and a definite locality, nothing which could be said, as a matter of scientific knowledge, to possess vibratory power could be used in any way in connection with a telephone without infringing Edison's patent rights. Regarding the filament in an Edison incandescent lamp and the carbon pencil in the lamp of Swan, Mr. Justice Butt says, it may be a question of degree, but degree is all-important. Although a carbon pencil $\frac{1}{25}$th of an inch in diameter has been called a filament, it is not the carbon filament which Edison contemplated when he used the expression in his specification. And thus the two judges differ in their method of dealing with the language of a specification. One says, it would be unfair to Edison to limit his meaning; the other, it would be unfair to him not to do so.

As no doubt the greater part of our readers are now aware, it was upon this question, whether the carbon rod or pencil in the lamp which Mr. Swan exhibited and described at Newcastle-on-Tyne in the year 1878 could fairly be called a filament, that the whole case eventually turned in the action decided last week, "Edison and Swan United Electric Light Company *v.* Woodhouse and Rawson." Many other reasons were brought forward in the first instance to show, first, that the Edison patent of December, 1879, which was the subject of the action, was not valid, inasmuch as it had been antedated by numerous inventors and scientists, and, secondly, that, even though valid, the defendants had not infringed it. No less than 75 anticipations were alleged; but as the case proceeded it was evident that these would have but little weight with the judge, who, at a comparatively early stage, intimated his doubts whether a lamp of mosaic construction, consisting of the glass receiver of one man, the carbon filament of another and the vacuum of a third, was an anticipation of Edison, who claimed the combination of these things, and not each one separately.

Upon the evidence with regard to anticipation, it seems to us that but little fault can be found with Mr. Justice Butt's decision. But when we take a wider view, we are not quite sure that there is abundant reason for satisfaction with the result. In the first place, it seems a pity that Mr. Swan himself was not put into the witness box. Had he been examined, he might have been induced to tell something of the experiments he made with carbonised paper as far back as 1860 or 1861, and of the carbon wire, "steel-like in its elasticity," and $\frac{1}{100}$th of an inch thick, which he also used with some degree of success. (See ELECTRICAL REVIEW for December 1st, 1880, page 409.) Indeed, it is curious that these points were overlooked, or were not adverted to, at the recent trial. Then, the construction which the Court put upon the second claim in Edison's specification was not quite that which we have been accustomed to regard as the right construction. We have always considered that the strength of the patent lay in the filament—a special conductor, made as described; that is to say, a filament formed by carbonising a vegetable base. To this we think Edison is entitled; but such a lamp as that of Cruto, in which pure carbon is deposited upon a platinum wire, and in which, therefore, no vegetable base is employed, would surely be outside the Edison claims. With regard to the Woodhouse and Rawson filament, there was no evidence which more than suggested the possibility of its having been "made as described" by Edison.

Mr. Justice Butt, however, took the view, in which we cannot follow him, that the terms of the specification are to be taken as meaning *any* carbon filament, *however made.* True, it is the first claim which alone specifically mentions "a filament of carbon . . . . made as described," and of this claim the learned judge held there was no infringement. But surely it is not unreasonable to say that Edison implied the same thing when he wrote, in his second claim, "a carbon filament," without adding the further descriptive phrase contained in the first. It is in this respect, and in this alone, that we differ from the finding of the Court. It is a pleasure to say that the learned judge consistently sought throughout the trial to reduce matters to the simplest and plainest issues, and to avoid those legal quibbles and niceties for which a case of this character offers considerable opportunity; and if we cannot unhesitatingly concur in his decision, we can bear testimony to his conscientious endeavour to take the proper view of the evidence, difficult, and in some cases conflicting, which was put before him.

We presume the case will proceed to appeal, and, in that event, trust that the party which has right and justice on its side will ultimately secure the verdict; but we do hope that, should Mr. Justice Butt's decision be confirmed, electric lighting will not be retarded as a consequence.

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HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

VI.—COMPOUND MACHINES.

LET it be required to wind the machine compound, that is, with both series and shunt coils, so that the difference of potential at its poles shall remain constant, or nearly so, for any number of lamps.

The general principle of the compound winding is as follows: In a simple shunt machine, the greater the current in the external circuit or in the armature, the greater will be the fall of potential in the armature itself, due to its resistance, and therefore the less will be the potential at the terminals of the shunt coils. This decreases the current in them, thus diminishing the magnetism, which again decreases the potential. The potential at the poles of the shunt machine must, therefore, fall a certain definite amount with an increase of the number of lamps in circuit. The increased "counter magnetism" of the armature, due to its own current, also tends to decrease the potential for an increased current.

If by some means these losses of potential due to an increased current could be replaced automatically by an exactly equal amount by increasing the magnetism proportionally, it is evident that the potential at the poles could be made to remain constant, or nearly so. This may be done by adding series coils to such an amount that the total magnetism of the field increases with an increasing current in the external circuit, so that the potential at the poles of the machine is maintained constant. To show how to properly proportion the series and shunt coils so that the machine will give this constant potential at its poles, is the object of this article.

The connections of the shunt coils may be made in one of two ways. In the first of these, called the ordinary compound machine connection, and shown in fig. 3, the terminals of the shunt coils are connected to the poles of the armature, or what is the same thing, to the brushes. The current in the series coils is, therefore, not the total current of the armature, but the current in the external circuit, or what is the same thing, the armature current less the shunt current. When no lamps are burning, the series coils are idle, the shunt coils alone being used to keep the machine at its proper potential. If the potential at the poles of the machine is constant, it will not be so at the poles of the armature or at the brushes, and, therefore, not at the terminals of the shunt coils. The potential at the latter will be equal to that at the poles of the machine, increased by that which is absorbed in the series coils, which latter quantity is evidently the current in the external circuit multiplied by the resistance of the series coils, and is, therefore, a variable quantity depending on the number of lamps in circuit. The current in the shunt coils is, therefore, not a constant one, but depends to a small extent on the number of lamps burning.

The second system of connecting the coils is called by Prof. S. P. Thompson the "long shunt" method, and is shown in fig. 4. The terminals of the shunt coils are not connected to the brushes as before, but to the poles of the machine. The potential at these points being constant, the current in the shunt coils is constant for all loads, and represents, therefore, a constant magnetisation such as from steel magnets or from a separate exciting machine. The current in the series coils is in this system the whole current of the armature, because the current passes from the brushes directly into the series coils and afterwards divides between that in the external circuit and that in the shunt. The series coils act to a certain extent both as series and shunt coils, for the current in the shunt coils flows through the series coils as well, and when the machine is on open circuit, the shunt current has to flow through the series coils first, thus making them act as shunt coils also.

It is a question which of these two systems is more economical as regards material, operation and construction, though it is probable that the second or "long shunt" method is the better. In regard to material, the second is probably cheaper, for although there is a trifle more lost space between the wires, owing to the thicker wire of the series coils, yet there is less space and material wasted in the insulation. For suppose we were to wind a thin shunt wire and a thick series wire together to take the place of the single series wire of the second method which carries both these currents, the two wires would evidently take up more room and would cost more in material than the one thick wire, although answering the same purpose. In regard to the economy of operation of the two systems there is probably very little difference. There may be a slight difference in favour of the "long shunt" method, because the magnets will be slightly less bulky. In regard to economy of construction, there is less work required to wind the magnets in the second case, as there are always less windings in all. If certain errors in the calculations, which may often be neglected, are corrected, the long shunt method becomes somewhat easier to calculate than the ordinary. In many cases, especially for large, well-proportioned machines, there will be very little practical difference between the two methods.

The test of the machine, preceding the calculations for the proper proportions of the series and shunt coils for either the ordinary or the long shunt method, is the same for both, and is made as follows, independently of the method of winding which will be used.

Make the test for determining the magnetism, with temporary coils and a separate exciting machine, in the same way as was described for shunt machines, only that instead of making but one test for full load, make a series of tests (as many as practicable—say 15 to 20) beginning with a little more than full load, and continuing by diminishing the number of lamps, down to an open circuit or no lamps. For each different number of lamps, adjust the exciting current until the potential is the required amount and then measure both the exciting current and that in the lamp circuit, being careful that the speed remains the same, for with a poorly governed engine the speed is likely to increase as the number of lights diminishes. The speed should be noted and *must not be changed*, as the proportioning of the coils is different for different speeds. The machine should be run for a time on full load or even more, so as to become warm throughout. In the absence of a reliable ampèremeter for such a large range as is required for the current in the external circuit, it is sufficiently accurate, if the lamps are uniform, to calculate the current in the external circuit from the number of lamps, by measuring accurately, once for all (and with the same instrument to be used for the exciting current) the current required by a large number

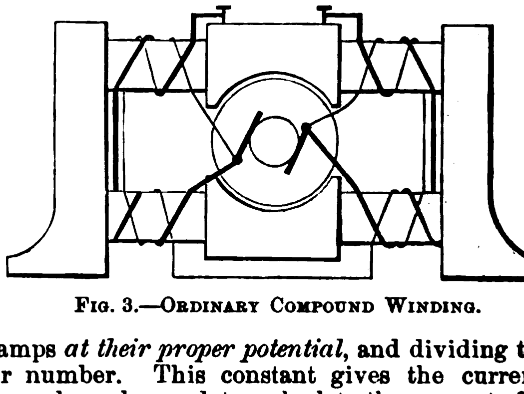

FIG. 3.—ORDINARY COMPOUND WINDING.

of lamps *at their proper potential*, and dividing this by their number. This constant gives the current per lamp and can be used to calculate the currents for the decreasing number of lamps. In this case, even if the constant of the instrument is not quite correct, the relative values of the lamp current and the exciting current are correct, and the test will give values which will answer the purpose. It is important to adjust accurately for the proper potential in each case, otherwise the results will be very unsatisfactory.

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Before making this series of measurements it is advisable to examine the shifting of the diameter of commutation. To do this, run the machine at full load at the proper potential and adjust the brushes to the non-sparking position, then disconnect all but a few of the lamps, and run it again at the proper potential by changing the exciting current, and find the non-sparking position of the brushes again. If the change of position is very great, it is not advisable to attempt to make the machine a self-regulating compound machine, as it will be very unsatisfactory; in fact it will evidently not be automatic if the brushes require to be adjusted. If the change of position is great, there are some wrong proportions in the machine, at least, for a compound machine. Probably it is the fault of the armature, as it may have too many windings, or its iron may be too hard, or there may be too few commutator strips, the self-induction being too great. It may also be the fault of the pole pieces, as they may be too wide in the direction of rotation. Perhaps the field is unbalanced, having the iron unsymmetrically placed in the form of arms, bearings, base, &c. The brushes should not touch more than two, or at the most three commutator strips at one time, and they should be precisely diametrically opposite each other. General hints, in regard to the best proportions, to prevent the shifting of brushes, will be given in the latter part of this article.

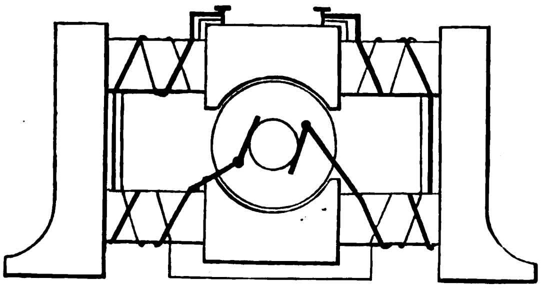

FIG. 4.—COMPOUND WINDING—LONG SHUNT.

If the change of position of the brushes is more than about one-half inch, on a commutator of about 4 inches diameter, the machine is not well proportioned. A good compound machine ought not to spark or require the brushes to be moved, even for a sudden change from a full load to an open circuit or the reverse. They should only be moved when worn off. It is, of course, taken for granted that the contact surface of the brushes is more than the thickness of one insulation between the commutator strip, and that they are exactly diametrically opposite each other.

If the brushes need slight adjusting, it is best to find a mean position, and keep them there for all loads, provided they do not spark too much to injure the machine for the extreme loads.

INCANDESCENCE LIGHTING.

IN the present article we return to the subject treated of in our leading columns a few weeks ago, and to the solutions which we mentioned as being of special importance in connection with the life of glow lamps. The problem to be solved is at what strain * should lamps be worked to obtain minimum annual expenditure when the power is supplied by a gas engine burning London gas at 3s. per 1,000 cubic feet, assuming the relation given in our former article between the strain and the duration to be true? We shall deal with an installation of 50 lamps of 20 candle-power, the total light produced being, therefore, 1,000 candles, and we shall further assume that the lamps are lighted for 1,000 hours annually. The actual strain on lamps as now installed varies from ·2 to ·4, and we will confine our remarks to lamps within those limits, taking their cost at 5s. each.

The consumption of gas in gas engines has been determined at 30 cubic feet per brake horse-power per hour, and by calculation, knowing the commercial efficiency of the dynamo, the number of watts appearing in the lamp circuit for each cubic foot of gas consumed per hour could be easily determined. But it is probable that a calculation of this sort would give a result too high, since in driving from gas engines with a fly-wheel on the dynamo a certain amount of slip must be allowed, which means a small loss of power. Our best plan is therefore to trust to no calculation, but to measure directly the gas consumed and the electrical energy appearing in the circuit, all losses in transmission being thus included in the results. From several determinations of the relation between the gas consumed and the watts appearing in the lamp circuit it seems that for each cubic foot of gas consumed per hour an average of about 17 watts can be obtained from a gas engine combined with a good dynamo. About 25 cubic feet of gas is consumed for each indicated horse-power developed by the engine, and having a list of engines with their horse-powers given we can find what amount of gas each is capable of burning by multiplying the I.H.P. by 25. To obtain the number of watts which the engine and dynamo combined are capable of producing in the lamp circuit, this product must be further multiplied by 17.

What we have to determine first is the initial cost of the installation, and this must be somehow expressed in terms of the strain on the lamps. We know that if the strain is high a less amount of power will be required, and consequently a smaller size of gas engine than if the lamps are worked at a low strain. In Table I. are given the costs of various sizes of Otto gas engines including fixing and foundations. Since in our calculations we are limited by strains of ·2 and ·4 respectively, we have only taken engines which supply power between 5,000 and 2,500 watts, which output for 50 lamps corresponds to these limits.

TABLE I.

COST OF OTTO GAS ENGINES.

I.H.P.	Gas consumed per hour.	Watts in lamp circuit.	Strain.	Cost in £.
5·9	147·5	2507·5	·398	190
11·5	287·5	4887·5	·204	230
14·7	367·5	6247·5	·160	270

Column 2 of the table is obtained by multiplying the I.H.P. by 25, and represents the maximum amount of gas which the different sizes of engines are capable of burning with economy. Column 3 is found by multiplying column 2 by 17, and may be considered the maximum number of watts which can be obtained from the engine and dynamo combined.

The costs of dynamo machines giving an output varying from 2,500 to 5,700 watts as published in the price lists of well-known firms are given in Table II., and include fixing, foundations and belting. The relation between the cost of the machine and the strain on the lamps is also given in the table.

TABLE II.

COST OF DYNAMO MACHINES.

Watts in lamp circuit.	Strain.	Cost in £.
2,500	·400	60
3,200	·312	70
4,400	·227	80
5,700	·175	90

* Our readers will remember that "strain" is defined as the fraction of candle-power given by the lamp per watt of energy consumed.

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From these tables it will be seen that the cost of the gas engine cannot be regarded as a simple function of the strain, nor can the cost of the dynamo. Looking at Table I. we find that if it is wanted to diminish the strain by ever so little less than ·398 we must put in an engine costing £40 more, which is, however, capable of working the lamps at a strain of ·204. Any line then which may be drawn to express graphically the relation between the strain and the cost will not be a curve, but will be a line ascending in a series of steps and made up of horizontal pieces joined by vertical

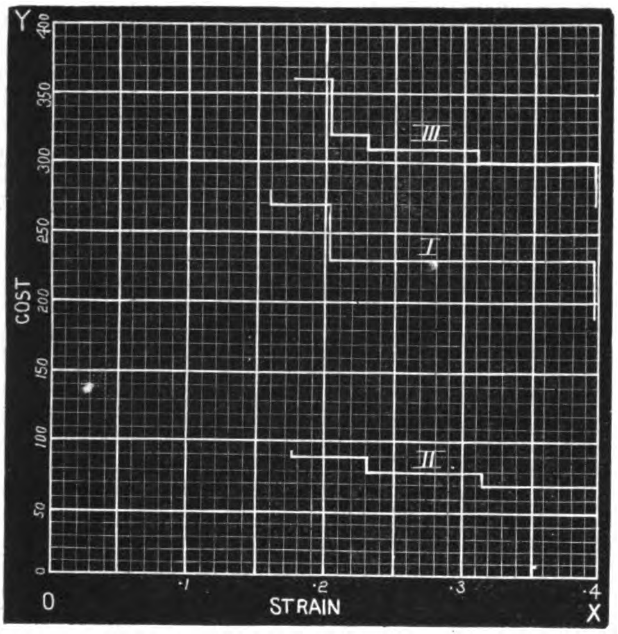

FIG. 1.

pieces, as shown in fig. 1. Here distances along O X represent strain and vertical heights the cost. Line I. represents the cost of the gas engine and II. that of the dynamo, III. being the sum of the two.

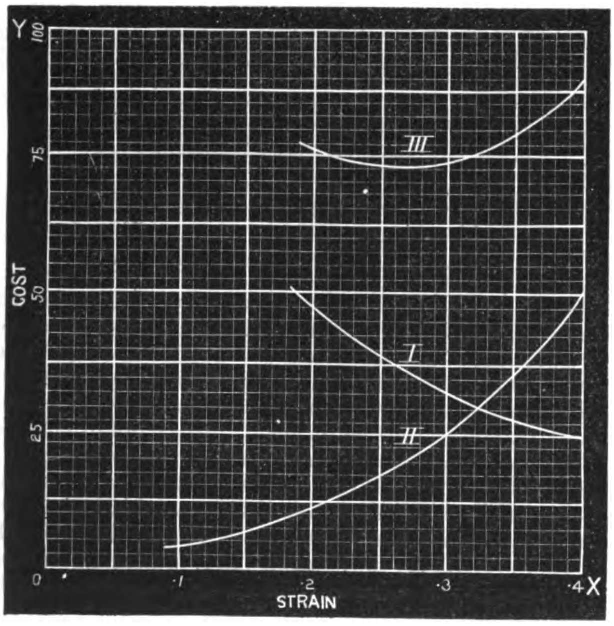

FIG. 2.

The lamps we have taken at 5s. each, and allowing 25s. per lamp as the cost of supplying and fixing conductors, switches and fittings, we have £75 as the sum to be added to the cost of the engine and dynamo in order that the total initial cost of the installation may be represented. It might be said that the items enumerated above are not independent of the strain, inasmuch as when the lamps are less strained the size, and consequently the cost, of the conductor becomes increased. Although this is true, we do not consider it worth our while to find how the cost of the conductor will vary with the strain, since the modification introduced by this consideration would be very trifling. We shall therefore imagine that the cost of the conductors is not influenced by the strain, and that the only costs depending on the latter are those of the engine and dynamo. We shall add the above £75 to the cost of engine and dynamo and take the interest, depreciation and repairs at 10 per cent. per annum all round. Line I. fig. 3 represents for different values of the strain this annual cost due to interest, &c., on capital sunk.

So much for the annual interest cost. We have now to consider the cost of maintenance. The maintenance cost embraces the charges for attendance, for lamp renewals, and for fuel and oil. The former of these is, of course, independent of the strain and may be taken at £15 per annum, the proportion of a lad's time occupied in cleaning the engine, &c., being charged under this head. The lamp renewals depend on the strain at which the lamps are worked, so does the gas consumption, and finally, the cost of the oil used may be considered as related to the cost of the gas in the way shown in Table III. This table gives the annual maintenance cost on the assumption that lamps strained to ·2, ·3, or ·4 last respectively 1,000, 500, or 250 hours.

TABLE III.

ANNUAL MAINTENANCE COST FOR 50 LAMPS.

Strain.	Watts.	Gas consumed in thousands.	Annual cost of gas.	Annual cost of oil, &c.	Annual cost of lamp renewals.	Attendance charges.	Total maintenance cost.
·2	5000	294	£44·10	£4·4	£12·5	£15	£76·00
·3	3334	196	£29·40	£3·0	£25·0	£15	£72·40
·4	2500	147	£22·05	£2·5	£50·0	£15	£89·55

We have now the annual interest cost and the annual maintenance cost expressed in terms of the strain, and by plotting these as curves, their values being represented by ordinates and the strain by abscissæ, we can illustrate graphically the relation existing between them. Such curves are given in fig. 2, where I. is the annual cost of gas and oil, &c., and II. the annual cost of lamp renewals. Curve III. gives the total maintenance cost, and in fig. 3 this is combined with the annual interest cost to obtain the value for the strain which makes the total cost a minimum. Line I., fig. 3, is the interest cost, and line II. the maintenance cost, and it will be seen that the sum of these two costs, III., has a minimum value when the strain is ·275 or when we expend energy at the rate of about 3·6 watts per candle-power.

It will be understood that this is true only on the assumptions which we have made regarding the cost of lamps and their durability. The factors affecting the result are numerous, and there must of necessity arise slight modifications for each installation treated, but we can say that, in the present stage of lamp manufacture, a lamp strained to ·275 is an economical one, and that in any case the most economical strain will not vary much to either side of that given. It will be observed that for a considerable variation in strain the total cost is not materially increased or diminished, the line for some distance remaining approximately horizontal at the lowest part of the curve (III., fig. 3), so that a certain latitude remains to us in the choosing of the lamps. It ought also to be remembered that the interest and maintenance charges which are independent of the strain—such as interest on first cost of lamps, fittings and wiring, and cost for attendance—while influencing the total annual cost, do not, by increasing or diminishing, affect the strain at which the lamps should be worked, which is influenced only by the variable factors. We need scarcely say that quite a different solution would be obtained with Dowson gas as fuel, for with diminished outlay for

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fuel, the strain would be reduced and a diminished annual expenditure would be the final result.

The second problem to be solved is, what must be strain to obtain maximum economy when the power is supplied by a factory engine, the power for the lights being so small relatively to the total power given out that the interest on the motor supplying it may be in our calculations neglected? We shall suppose that the installations consists of 300 lamps of 20 candle-power each, the total light given being that of 6,000 candles, and we shall further suppose that they are lit for 1,000 hours per annum. The price of fuel varies so much in different districts that we encounter at the outset some difficulty in fixing the cost of the power, but we believe we shall be sufficiently near the mark if we assume that for every 1,000 watts appearing in the lamp circuit we have to pay annually in fuel, oil, &c., £3. This figure includes, as in the case of gas engines, all losses in transmission; we are concerned only with the fuel put into the furnace at one end and the watts appearing in the circuit at the other.

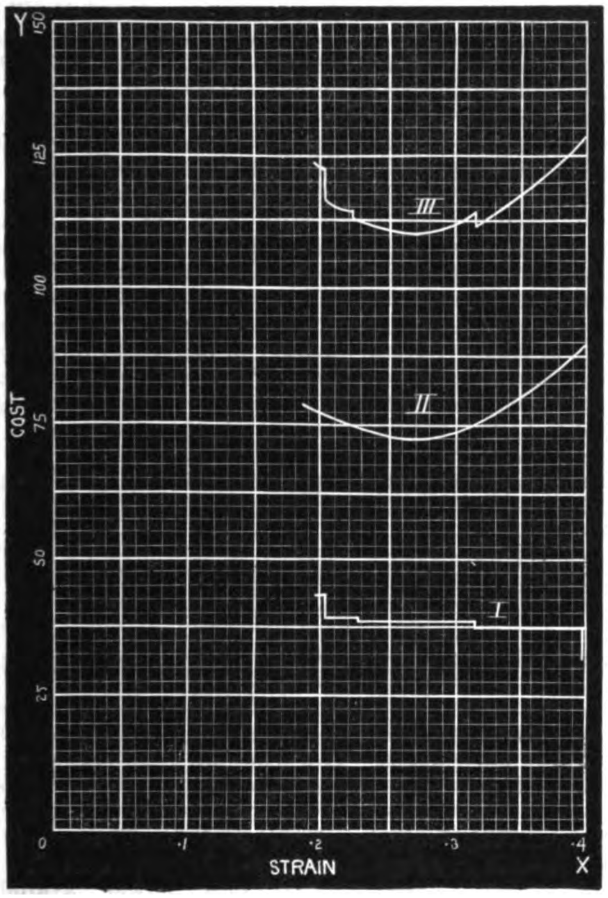

FIG. 3.

The following Table IV. gives the cost of the dynamo, and, as before, includes price of belting, of foundations, and of fixing in place.

TABLE IV.

COST OF DYNAMO MACHINES.

Watts in lamp circuit.	Strain.	Cost in £.
15,800	·380	200
18,900	·317	210
22,200	·270	225
25,200	·238	280
28,400	·211	300
31,600	·190	320
47,400	·127	440

The supplying of lamps, conductors, fittings, &c., may, for an installation of this kind, be taken at 22s. 6d. per lamp, which makes a sum of £337 10s. to be added to the cost of the dynamo in order that the total first cost may be obtained.

The cost of maintenance is given in Table V., £60 per annum being charged for attendance.

TABLE V.

ANNUAL MAINTENANCE COST OF 300 LAMPS.

Strain.	Watts.	Annual cost of coal and oil.	Annual cost of lamp renewal.	Attendance charges.	Total maintenance cost.
·1	60,000	£180	£18·75	£60	£258·75
·2	30,000	£90	£75·00	£60	£225·00
·3	20,000	£60	£150·00	£60	£270·00
·4	15,000	£45	£300·00	£60	£405·00

It is not worth while repeating all the graphic representation for the solution of the problem, so we merely give the result. Taking the interest, depreciation, and repairs at 10 per cent., as before, the annual cost is shown to be a minimum when the lamps are strained to ·2, or where the energy absorbed is 5 watts per candle. The latter result will probably astonish electricians who have been eager in the pursuit after lamps taking 2½ watts per candle, or less. Of course it could be seen without any calculation that in working with a steam engine the strain should be less than when a gas engine is used, owing to the diminished cost of the fuel employed. As a matter of fact the whole question hangs upon the relation between the strain on the lamp and its duration, and we have only had data of a not very satisfactory kind to rely upon for this. With the data at our disposal we have, however, done our best, and we believe the relation we have given is a fair one. Upon the life of the lamp depends the cost of renewals, and if lamps were cheaper we could afford to put a greater strain on them and thus lessen the annual cost. Having regard to recent law proceedings it is not likely that lamps will be cheaper for some time, and improvements serving to increase their duration seem to take place but slowly. With lamps at their present prices, and with their present lasting powers, a lamp taking 4 watts per candle, or strained to ·25, is a good average lamp to be used on any installation whether the power is supplied by gas or steam.

WIMSHURST'S INFLUENCE MACHINE.

THE Wimshurst influence machine is now extensively known, and is fast replacing other electro-static generators in use in physical laboratories. Its rapid introduction is due mainly to three characteristic features, viz: (1), its remarkable independence of atmospheric condition; (2), its power of self-excitement; and (3), its constancy of polarity.

It has given every satisfaction without any preliminary treatment in crowded lecture theatres in which other influence machines behaved most disappointingly. It has also been frequently placed in trying and even in extreme hygrometric conditions, and found to work admirably. As to initial electrification, it never wants any. As soon as the varnished plates with their metallic sectors are fitted with their brushes and spun round in proximity to each other, a charge is invariably and rapidly built up. One side of the machine becomes positive with respect to the other, and this electrical state is maintained as long as the machine is kept working.

Much useful information as to the manner of making and using these machines may be obtained from a little pamphlet published lately by Mr. Thomas Gray, C.B. This work is a reprint of matter which appeared in the *English Mechanic* between November, 1884, and October, 1885, to which Mr. Gray adds some experi-

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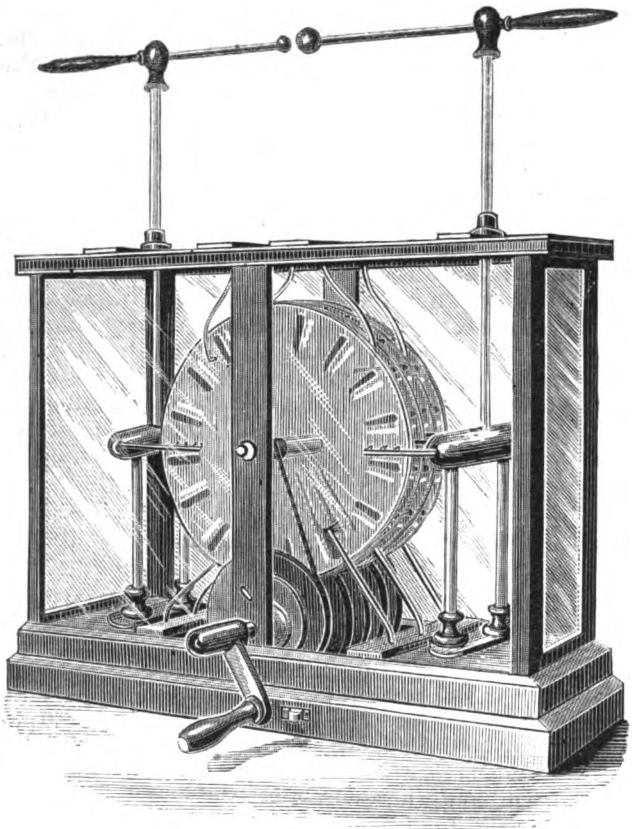
ments made with his multiple-plate machine bearing chiefly on the flow of the electrical current.

The machine, the illustration and description of which we reproduce from *Engineering*, is the latest one constructed by Mr. Wimshurst in his amateur workshop at Clapham. It consists of eight of the well-known plates—which may henceforth be aptly called by the distinctive appellation of Wimshurst plates—each being $2\frac{1}{3}$ feet in diameter and carrying sixteen sectors. When the plates are rapidly rotated in opposite directions, a high degree of electrification is produced. In order to diminish as much as possible the loss of charge arising from the usual causes, all the conductors, and even the rods carrying the metallic brushes, are covered with a thick coating of gutta percha, and the whole apparatus is enclosed within a tightly-fitting and dust-excluding glass case. In like manner, the brass rods which lead from the prime conductors to the outside terminals, are carried up through glass tubes. By these means, the losses due to leakage and discharge to neighbouring bodies are greatly reduced, and the efficiency of the machine correspondingly increased.

Some idea of the electrical power developed by this machine may be formed from the easily reproducible fact that every turn of the handle gives six sparks each of 8 inches in length. One complete revolution, therefore, generates a quantity of electricity corresponding



to a disruptive discharge of 4 feet length. Sparks of 10 inches and 12 inches are readily obtained. Some of the former have been photographed and are remarkably beautiful, showing in a marked manner the multiple and branching character, as well as the zigzag path of the discharge between terminal and terminal.

The condensers used were made of ordinary hock bottles, and the discharge was accompanied by an almost unbearable snapping noise, comparable in loudness to a pistol shot.

This machine was specially constructed for the course of afternoon leetures now being given by Prof. George Forbes at the Society of Arts. In one of these, in order to show the strain produced in a dielectric medium when acted upon by an electromotive force, the professor endeavoured to repeat a famous experiment of Dr. Kerr's. Two wires leading from the terminals of the machine, dipped into mercury contained in two small glass bulbs. These were immersed at a little distance from each other in a cell containing carbon disulphide. A beam of polarised light was then passed through the liquid, and the analyser turned until the light was cut off. It was duly explained that the stress to which the liquid dielectric (CS_2) would be subjected on turning the machine would be made manifest by the reappearance of the light on the screen. The stress, however, proved to be so great as to noisily shatter the glass bulbs before any optical effect could be perceived. The point was thus demonstrated in an unmistakable and probably unwished-for manner. The same principle of strain was again illustrated in the case of Leyden jars by separating the terminals of the machine as far as possible, and rapidly rotating the plates. Though the walls of the jars were unusually thick they were unable to resist the intense electrostatic strain produced by the high electromotive force of the machine. This electromotive force has been measured in terms of that of a Daniell's cell, and found to be 50,000 volts, while the current has been estimated at the $\frac{1}{3000}$th of an ampère.

In an elementary class-book on electricity just published,* we notice that one of the sections is headed "The Voss or Wimshurst Machine." This evidently implies the identity of the two electrostatic generators, which is an error. Moreover, when the author, proceeding with his description of the Voss, says that "one plate is fixed," he has said quite enough to convince any one who has ever seen a Wimshurst that the two machines are essentially different. As to the principle involved, they, as well as all other influence machines, are based upon Nicholson's "doubler."

In this connection it may be interesting to state that a series of measurements has been made for the purpose of comparing the quantity of electricity developed respectively by a Voss and a Wimshurst machine provided with plates of equal diameter, the result showing that the latter yields three and a half times as much as the former.

The machine which is pictured above was exhibited at the recent Royal Society conversazione. It attracted considerable attention, as did also the photographs of the spark discharge.

TOWN ELECTRIC LIGHTING IN FRANCE.

BOURGANEUF, a small town in the middle of Creuse, has just adopted electric lighting, with every prospect of complete success. The example thus set will, no doubt, be followed in many places where the conditions laid down by M. Ernest Lamy, the projector of these installations, can be observed. The system is suitable for those towns that are not already lighted by gas, and is worked by hydraulic power, available during the day for various industries and during the night for lighting.

Contracts for lighting are made by M. Lamy with these little towns similar to those made for lighting by gas, for a period of 40 to 50 years, he undertaking municipal lighting and the lighting for private consumers as far as the power at his diposal will allow. The public lighting is supplied by contract, that of private persons is rated by the meter.

The lighting of the town of Bourganeuf comprises, besides 60 street lamps, the entire lighting of the town hall, with 20 lamps; the church with 7 lamps; cafés, hotels, shops, &c., amounting to about 106 lamps, the installation being capable of maintaining about 300. The working of the system is in the hands of M. Marcel Misme, mill owner.

The motive force is produced by an old trough wheel 5 metres in diameter, making only 6 revolutions per minute. This primitive motor is disadvantageous for a fall of about 11 metres, but with a suitable turbine capable of working the machine direct it would be easy to obtain the 25 to 30 H.P. necessary for the

* "Electricity Treated Experimentally," by L. Cumming, M.A.

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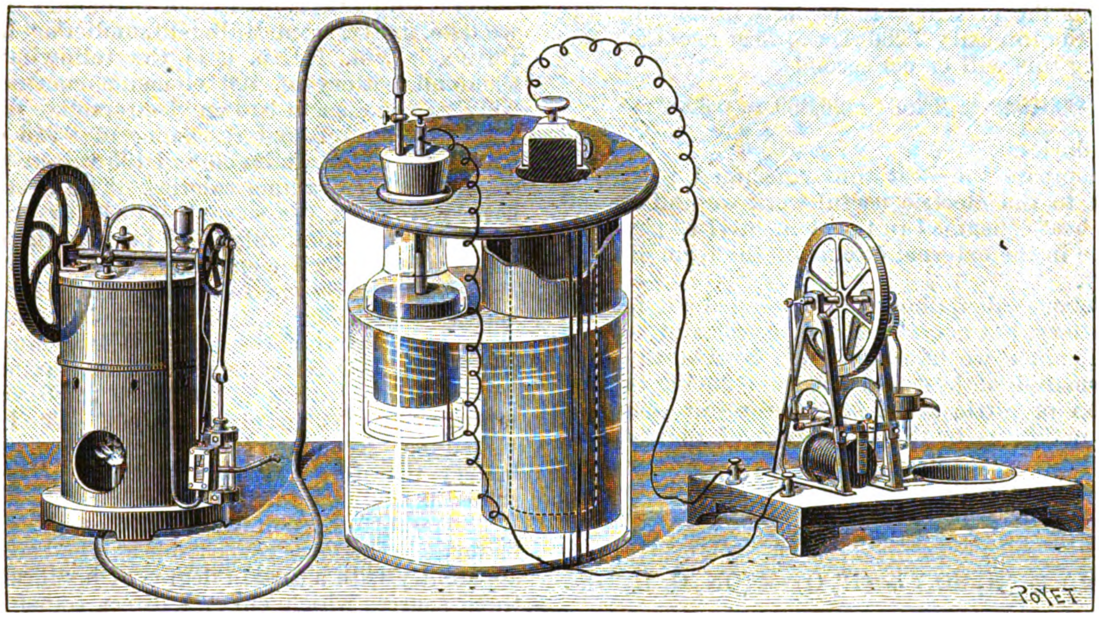
complete installation. This improvement will soon be made.

The current is supplied by a Thury dynamo machine with 6 poles, compound wound, running at 450 revolutions per minute and giving normally 110 volts at the terminals and 180 ampères, but capable of giving as much as 225 ampères without danger. The wires are overhead, and laid on insulators.

The lamps are all on the Woodhouse and Rawson system, 10 candle type, requiring, according to the distance from the works, a distance amounting to 1,750 metres for the farthest lamp, from 80 to 90 volts and about 0·3 ampères. These low power lamps certainly facilitate the distribution, and this installation will furnish some useful information as to the duration of these lamps when in service. The public lamps are all lighted when the dynamo is started and only extinguished when it stops. The fittings are very tasteful and the lamps ingeniously distributed so as to give a satisfactory light with the least possible number.

THE TRANSFORMATION OF PHYSICAL FORCES.

ONE of our readers in Monte Video, says *La Nature*, M. E. Paccard, sends us a description of an arrangement of Bunsen battery by means of which he carries out a very curious experiment upon the transformation of physical forces. Our illustration shows the arrangement.



Let us first examine the construction of the battery. The zinc, instead of being formed of a cylindrical plate surrounding the porous pot, is a single massive cylinder, suspended under a bell glass, fixed itself to a cover of wood which hermetically closes the whole system by means of wax or mastic.

The bell glass passes through the cover; it is closed by a stopper of India rubber with two tubes. Through one of these tubes passes a copper rod which supports the zinc and which serves as an electrode. The other tube is provided with a cock which allows the hydrogen gas formed to escape. This cock, when opened or closed, opens or closes the circuit. In fact, in the first case the hydrogen escapes, and in the second, having no means of issue, it accumulates in the bell and forces out the liquid: the battery ceases to act as soon as the zinc is uncovered.

At the side of the bell just described is placed in the ordinary way the carbons and the porous pot containing the nitric acid.

The experiment is conducted as follows: the wires fixed to the two terminals are connected with a small electric motor which is seen on the right of our illustration and which works as soon as the contact is established. The hydrogen disengaged is, on the other hand, conveyed by means of an India rubber tube under the boiler of a small steam engine shown to the left of the engraving. The gas is ignited, the water soon boils, and the engine begins to act.

We have thus at the same time a generator of heat and of electricity: it is a beautiful experiment which we recommend to physicists.

ON THE TRANSFORMATION OF HEAT INTO ELECTRIC ENERGY.

ACCORDING to the law of the conservation of work as applicable for all natural processes, writes W. Peukert, in *Central Blatt für Elektrotechnik*, we regard the electrical energy furnished by any source of a current as the equivalent of some other form of energy which is transformed into electricity by the action in the source of the current. In the above-named, hitherto most usual sources, it is fundamentally heat which undergoes such a transformation and is converted into electricity. In galvanic batteries it is the heat produced in them by chemical processes which is converted into electricity; in the thermo-piles there is a direct transformation of heat, which is conveyed as such to the several soldered joints of the elements into electricity. Even the energy furnished by dynamo machines can be regarded as produced from heat, only the heat conveyed to the motor of such a machine (in case of a steam or a gas engine) undergoes an intermediate transformation into mechanical energy which, when passed into the dynamo, is converted into electric energy.

From this point of view it is certainly an interesting question what percentage of heat is converted into electricity by the above-named sources of currents. It is the object of this memoir to carry out such an inquiry. We will firstly, without reference to cost, consider the proportion of transformation between heat and electricity from these various sources, and afterwards discuss the economic phase of the question. In order to allow of a more ready comparison we will consider only that portion of the total electric energy of a source which is available as utilisable work at the terminals and study its ratio to the heat consumed.

A.—*Galvanic Combinations.*

Of these we will consider only the Daniell and the Bunsen, as in both these not only have the chemical

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processes been accurately determined, but numerical data are at hand both for the developments and the absorptions of heat thus produced.

For Daniell's battery the chemical process may, as it is generally admitted, be represented by the following symbols :—

$$+ (Zn\ SO_4) - (H_2\ SO_4) + (H_2\ SO_4) - (Cu\ SO_4)$$

There is first formed sulphate of zinc; the heat thereby liberated is per equivalent of zinc (32·45 grms.) 54,191 gramme calories. The simultaneous decomposition of sulphate of copper represents per equivalent (31·58 grms.) a liberation of heat of 27,822 gramme calories; we obtain, therefore (the two other processes formation and decomposition of sulphuric acid mutually annulling each other) as the algebraic sum of the quantities of heat (which, since they do not appear as such, may be called heat mutations), 26,369 gramme calories.

If we now determine the maximum electric available work which we can command by means of a Daniell battery, we obtain this when the external resistance is equal to the internal resistance; hence we obtain, if we assume the electromotive force as 1·088 volt and the internal resistance as 0·24 ohm, 1·233 volt-ampère as the maximum effect. This corresponds to a quantity of heat of 0·296 gramme calories. The above-given sum of the heat mutations represents the solution of an equivalent of zinc or the precipitation of an equivalent of copper; to a current of the intensity = 1 A there correspond per second 0·00001038 equivalents; as in the present case we have in the circuit a current of the intensity 2·266 A, the heat necessary for maintaining this will be per second

$$0·00001038 \times 2·266 \times 26,369 = 0·6202$$

gramme calories.

If we compare the heat thus consumed with that equivalent to the electric useful work we find that of the entire heat consumed in the element 47·72 per cent. is available in the external circuit in the form of electric energy.

An analogous calculation may be carried out for the Bunsen battery, but not with the same certainty as for the Daniell, since we have not such trustworthy data for the formation of heat which occurs during the decomposition of nitric acid; still the result obtained gives us a notion as to the utilisation of the heat in this battery.

If we indicate a liberation of heat with + and an absorption of heat with — we obtain the following scheme for the process in the Bunsen battery:

$$+ (Zn\ SO_4) - (H_2\ SO_4) + (H_2\ O) - (ON_2\ O_4\ H_2\ O).$$

On substituting the quantities of heat corresponding to all the several processes, we obtain as the algebraic sum of all the mutations of heat

$$54,191 - 46,462 + 34,450 - 5,010 = 37,169$$

gramme calories.

We assume the electromotive force of the Bunsen element as 1·9 volt, the internal resistance as it appears in large elements 0·06 ohm; we have then for the maximum electric available work the value 15·039 volt-ampères, to which corresponds a heat of 3·611 gramme calories. According to the assumption made for the constants of the element there circulates here a current of the intensity of 15·83 ampères; the heat consumed in the element per second for its maintenance is found according to the calculation made in the case of Daniell's element as 6·107 gramme calories, of which in this case 59·1 per cent. are available in the outer circuit.

B.—*Thermo-piles.*

We shall here consider merely those thermo combinations whose constants are accurately known, and for which the consumption of gas or fuel has been determined. For the best verified Rebicek's thermo-piles we make use of the values which H. Kayser has ascertained. A star-pile of 20 elements had an electromotive force of 1·92 volt with an internal resistance of 0·717 ohm. The consumption of gas per hour was 90 litres. For the maximum electric available work we obtain in this case 1·2845 volt-ampères, whilst the equivalent quantity of heat is 0·3085 gramme calories. If we calculate the quantity of heat evolved per second by the combustion of 90 litres of gas, taking the weight of a cubic metre of coal gas as 0·696 kilos. and its combustion heat per kilo. as 10,600 calories, the heat required per second for warming the thermo battery is found to be 184·44 gramme calories. Of this heat 0·3085 calorie, *i.e.* 0·16 per cent., are available in the outer circuit.

For a star battery of 25 elements with an electromotive force of 2·06 volts and an internal resistance of 0·774 ohm, the hourly consumption of gas was 100 litres, and consequently the heat evolved per second 204·933 gramme calories. From the constants of the battery there appears the maximum effect as 1·369 volt-ampère, representing 0·329 gramme calories, so that here again 0·16 per cent. of the heat consumed is available in the outer circuit.

A Rebicek thermo battery, of the large type, having an electromotive force of 4·321 volts and a resistance of 0·778 ohm developed with an hourly gas consumption of 540 litres a maximum effect of 5·998 volt-ampères, representing 1·44 gramme calories. The consumption of heat per second amounts to 1,106·64 gramme calories, of which 0·13 per cent. can be utilised in the outer circuit in the form of electric energy.

For a similar examination of Clamond's thermo-piles we take, firstly, from Müller-Pfaundler's "Lehrbuch der Physik" (Vol. III. p. 607) the following data:—A Clamond battery of 100 elements consumed hourly 230 litres of gas and had an electromotive force of 2·07 volts and an internal resistance of 0·943 ohm. The maximum effect attainable is 1·135 volt-ampère, representing 0·2727 gramme calories. The heating of this battery required per second 471·346 gramme calories, of which, therefore, only 0·057 per cent. is transformed into available electric energy.

H. Kayser gives the following values for a Clamond battery which he examined:—electromotive force = 6·1 volt, internal resistance = 4·07 ohm, consumption of gas 350 litres hourly. The maximum useful effect of this battery is therefore 2·285 volt-ampères representing 0·549 gramme calories. The battery consumed per second 717·266 gramme calories. In this battery, therefore, only 0·076 per cent. of the heat consumed is available in the exterior circuit.

The transformation ratio of these thermo-electric batteries is the more remarkable as it had been assumed, apparently with a certain degree of justification that in these sources which effect a direct transformation of thermic energy into electric energy we should find the most rational utilisation of heat, and there has been ascribed to them an especial practical importance for the future. The figures obtained do not give the transformation coefficient of thermo-electric alloys and do not allow of an opinion as to its magnitude, which may be more considerable than is commonly supposed. They show merely, that of the heat evolved by the combustion of the fuel only a small portion is rendered serviceable for the purpose intended, since the surfaces to be heated have only a trifling extent, on account of the small section of the elements which often, in addition, carry polar appendages. The heat issuing into the air from the lateral surfaces of the elements does not undergo the maximum of utilisation of which it is capable on conversion into electricity. From this point of view we may understand the more considerable value of the transformation ratio of Rebicek's star batteries as compared with those with a straight line of fire, because in the former unnecessary losses of heat are somewhat obviated by the plate of mica resting on the heating plugs, thus rendering the heating more economical.

The above-mentioned experiments of H. Kayser also indicates a more rational utilisation of the fuel in Rebicek's batteries than in those of Clamond. They

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show for the intensity of the current, if the circuit is closed without resistance, calculated per litre gas, a mean value of 0·03 in Rebicek's batteries and in those of Clamond only 0·005.

A more favourable proportion than the batteries just described is shown by that of Clamond, heated with coke. When the hourly consumption of coke is 9 kilos the battery has an electromotive force of 218 volts and an internal resistance of 31 ohms. If the heat of combustion of coke is assumed as 7,100 calories per kilo. we obtain a useful electric energy of 0·518 per cent. of the heat consumed.

We will now, with reference to the utilisation of the heat in a thermo battery, compare it with a heat engine and raise the question how much electric energy is yielded by the heat consumed in a thermo battery if it is first converted into mechanical energy by a heat engine, and transferred by the latter into a dynamo machine.

As is well known, we obtain the available work of a heat engine by the formula

$$L = \frac{Q\,(T_1 - T)}{A\,T_1},$$

where Q is the heat received and T_1 and T the absolute temperatures between which the cyclical process is carried on. In order to have the most closely similar conditions, assume, also, for the thermo batteries that here, as in heat engines, only 50 per cent. of the total heat of combustion is made available. For Rebicek's thermo batteries we can put approximately the temperatures of the heated and cooled junctions as 600° and 50°, so that $T_1 = 600° + 273° = 873°$, and $T = 50° + 273° = 323°$.

We here obtain, certainly, for T_1 a temperature higher than the limit temperature in heat engines, in which the upper limit may be taken as 573°. But in spite of this circumstance the result obtained will allow of at least an approximate estimate of the transformation of heat by thermo batteries. If we put for Q in the above formula 0·0922 kilo. calories, according to the statements for the star battery of elements, we obtain as available work of the heat engine

$$0{\cdot}0922 \times \frac{550}{873} \times 424{\cdot}5 = 24{\cdot}65 \text{ metre kilos.}$$

We assume the degree of action of the heat engine as 0·5, so that we have 12·32 metre kilos. as the work transferred to the dynamo. If we suppose a direct transfer, so that no further losses have to be taken into consideration, and put the transformation ratio of the dynamo as 0·68, we have then an electric useful work of 82·18 volt-ampères, or, in round numbers, a value 64 times greater than the maximum effect of the thermo battery.

If we use the values for the two other Rebicek batteries above mentioned, we obtain by a similar calculation the figures 67 and 82.

Supposing that the same temperatures are reached in Clamond's battery heated with coke, we obtain for this battery the figure 20·6, *i.e.*, by means of a heat engine which carries on a cyclical process within the same temperatures, a dynamo would yield about 21 times more electric energy than this thermo battery.

In a similar manner Lord Rayleigh has compared a thermo-electric battery (consisting of nickel silver and iron) with a perfect heat engine and has found that the latter for an equal outlay of heat would yield 300 times more electric energy than the thermo battery.

These figures make it plain that thermo batteries, as hitherto constructed, are very far from effecting that rational conversion of heat into electricity which we are often inclined to assume, and that, on the contrary, they are far surpassed by dynamo machines driven by steam or gas engines. They must undergo very essential modifications and improvements before they can become capable of competing with the latter.

C.—*Dynamo Machines.*

As the motor of such a machine, we assume here a steam engine or a gas motor, and we must compare the electric energy supplied by the dynamo (in order to have the same conditions as in case of the other sources of currents) with the total heat yielded by the fuel, coal, or coal gas. It is not admissible here to consider merely the heat actually supplied to the boiler, and to take the available work thence resulting as a basis for further discussion, since the question is not the degree of effectiveness of the motor. We have to consider that the combustion heat of a certain quantity of fuel yields, after an intermediate transformation, a certain electric energy to the dynamo machine.

If we allow for the steam engine per hour and per horse-power a consumption of 1·8 kilo. coal, and take the combustion heat of coal as 7,500 calories per kilo., the heat liberated per second is 3,750 gramme calories. If we further suppose that the mechanical energy furnished by the steam engine is communicated without any loss to the dynamo, whose ratio of transformation is taken as 0·68, we obtain per second an electric energy of 500 volt-ampères, representing 120·07 gramme calories. By comparing this heat with that supplied by the fuel, we find that 3·2 per cent. of the latter is transformed into available electric energy.

If the motor is a gas engine, such as Otto's, which uses one cubic metre of gas hourly per horse-power, the heat consumed in a second would be 2049·3 gramme calories, of which, on the suppositions made above 120·07 calories, *i.e.*, 5·85 per cent., are made available by the dynamo in the form of electric energy.

We have thus far determined the proportion of the transformation of heat by the various sources only in a theoretical manner, and we have found that in this respect galvanic batteries permit of the most rational utilisation of heat, since, in comparison with the heat consumed, they furnish about ten times more useful electric work than dynamos ; and if we disregard the Clamond thermo-pile heated with coke, more than 200 times as much as thermo-electric batteries.

The conditions are altered when we take also the cost into consideration, the heat consumed in galvanic batteries being the dearest, since here zinc is burnt, whilst in the other sources coal or coal gas is used as fuel. We will therefore ascertain the cost price of a given quantity of useful electric work, as furnished by the above-named sources.

D.—*Calculation of Cost.*

In order to have the same conditions in all cases, we will undertake to determine the cost per hour of electric useful work of 500 volt-ampères, as furnished by galvanic batteries, thermo-piles, and dynamos.

If we retain the assumption made for the constants in Daniell's element, we find that 406 elements are required to give 500 volt-ampères. As we have a current of the strength of 2·266 ampères, it follows that one ampère precipitates per second 0·00001038 equivalent of zinc ; hence the hourly consumption of zinc per element is 2·7477 grammes, or for the entire number of the elements, 1115·57 grammes. If we take the price of 1,000 grammes of zinc at 0·5 mark (about 6d.) the cost of the zinc consumed is 0·558 mark.

The sulphate of copper used in the element need not be considered, as it is covered by the value of the copper precipitated. But the consumption of sulphuric acid must be noticed, which is only in part supplied by the dissolved sulphate of zinc. In order to dissolve 1115·57 grammes of zinc (taking the equivalent of sulphuric acid as 49, and of zinc 32·45), there are required 1684·52 grammes of sulphuric acid, which, taking 1,000 grammes (1 kilo.) at 0·3 mark, costs 0·505 mark, so that the entire cost of the Daniell batteries is 1·06 mark (slightly over 1s.). It must be remembered that we have here included neither a repayment of the first outlay, nor the labour required for attending to so large a number of elements.

We will also determine the cost of the material consumed in Bunsen's batteries, for which we have the following data. To yield a useful electric work of 500 volt-ampères, we require 34 elements if we assume the constants of the elements as above. As the strength of the current is 15·83 ampères, the hourly consumption

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of zinc per element is 19·195 grammes, or, in the total, 652·63 grammes, which cost 0·326 mark. The consumption of sulphuric acid, 985·48 grammes, costs 0·296 mark.

We have still to determine the nitric acid consumed and find this as 1,267·04 grms., as 32·45 grms. zinc represent 63 grammes nitric acid. If we take 1,000 grms. at 0·7 mark, the nitric acid costs 0·887 mark. Thus the total costs for the Bunsen battery, exclusive of first outlay and labour, is 1·51 marks.

As for the thermo batteries, if we use Rebicek's 20 element star batteries, 500 volt-ampères cost hourly 5·55 marks, or with 25 elements, 5·78 marks. Here, also, the repayment of first outlay is not included.

For the 50 element battery the hourly cost for 500 volt-ampères is 7·17 marks, and for Clamond's battery it even reaches 16·03 marks.

In Clamond's battery heated by coke, the working cost is about 0·42 mark without reference to first cost and depreciation, on which latter point no assumption can be made, as we have, so far, no experience as to its durability.

In computing the cost for dynamos we will make use of the communications of Prof. Pfaff concerning the price of the motive power. According to him the total working cost (inclusive of 10 per cent. as depreciation of the capital sunk, attendance, &c.) for one horse-power hourly when a fixed 50 horse-power engine is used with precision gearing and condensation, is 9·5 pfennige (10 pfennige = 1d. English), taking 3,000 working hours yearly.

If we calculate for the cost of the dynamo, its erection and arranging the transmission in round numbers 15,000 marks (£750) at 10 per cent. interest hourly per horse-power and 3,000 working hours yearly, the quota of depreciation is 1 pfennige, so that the total hourly costs for 500 volt-ampères are 10½ pfennige.

With an 8-horse gas motor under the same conditions, the hourly cost per horse-power is 23·16 pfennige. If we assume this price higher by 2 pfennige, we find then, with a depreciation of 10 per cent. for first cost and installation of the dynamo, the sum of 4,800 marks (£240), by which the above-named costs appear to be covered, so that in this manner the hourly cost of 500 volt-ampères comes to 25·16 pfennige. This price would come lower if the calculation were made for a more powerful motor.

For the sake of a ready comparison we will here collate the above results. An hour's electric work of 500 volt-ampères costs if produced by

		Marks.
Daniell elements		1·06
Bunsen		1·51
Rebicek thermo	star battery	5·65
	straight line	7·17
Clamond's thermo	with gas	16·03
	with coke	0·42
Dynamo, driven by steam		0·105
" " " gas		0·25

These figures show that the cheapest source of electric energy is yielded by dynamos driven by steam-power. Their striking superiority over the other sources of electric currents would be still more striking if in these also the cost of production were taken into account.

Electricity in the Royal Navy.—The *Mosquito* gunboat, at Devonport, having been selected by a committee, consisting of Captain Sir George Nares, Sir James Douglas, and Captain Nisbet, for service as "light vessel," is to be fitted with the electric search light. She will be movable from one part of the coast to another at a distance of from 300 to 400 miles. The *Jackal*, armed tug, which will shortly leave Plymouth for the Scottish coast, adjusted her compasses a few days since in the Sound, when under the superintendence of Commander E. W. Creak, of the Admiralty, experiments were made as to the effect of the electric light dynamo working on the compasses.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 476.)

Tuesday, May 11*th*, 1886—(*continued*).

DR. JOHN HOPKINSON, examined by Sir Richard Webster: Lane-Fox's lamp, described in specification 4,626, was not a practical lamp; it was less practical than other attempts which have been made in the same direction. In his final specification the part relating to the combination of the carbon conductor and mercurial float is left out.

Sir RICHARD WEBSTER: Now one question on the provisional specification of Scott, No. 861, of 1878: "When sticks or rods are to be made, they may either be made in the same way, or they may be made by forcing the plastic mass through a hole in a draw plate, or they may be made, when cylindrical in figure, by rolling portions of the plastic mass on a flat surface, or by the action of grooved rolls. . . . . My invention consists secondly in manufacturing flexible bands, ribbons or cords of carbon (or mixtures consisting essentially of carbon) to be used as hereinafter described in the production of light by electricity. I take the carbon or carbon mixture and incorporate therewith fibres of asbestos or fibres of hemp or other material or organic fibre, together with adhesive matter as hereinbefore explained. By rolling or otherwise I form the mixture into long bands, strips or ribbons, and dry them by heat. When the fibres are mineral the heat applied may be sufficiently high to decompose the flour or starch paste, but when organic fibres are employed the heat must not be so high as to decompose the said fibres." Does that description in any way indicate a filament of the same kind, or made in the same way, as Mr. Edison describes?—Certainly not; and the distinction is brought out exceedingly clearly by Mr. Edison, if you take the last sentence which you read: "But when organic fibres are employed the heat must not be so high as to decompose the said fibres," and compare it with what Mr. Edison says about enclosing it in a chamber and subjecting it to a high heat.

Look back three lines, at the beginning of page 2: "The articles thus produced may be coated with copper, applied as copper bronze, or deposited by electricity, or may be coated with plumbago, the said coatings having for their object to make the articles better conductors of electricity." Does that point to arc lighting?—I think that is what he is addressing himself to. He wants to get a flexible conductor for arc lighting.

Mr. JUSTICE BUTT: But will you go on: "My invention consists, thirdly, in making sticks, blocks, or pieces of carbon moulded from the plastic mixture herein first described of such a figure that when fixed close together upon a flexible band they show when the band is passed over a pulley," &c. Why is not a stick made of carbon moulded from a plastic mixture something like Mr. Edison's filament?—The manufacture of the sticks from a plastic material—mixtures of powdered coke and molasses, and so on—by moulding them and pressing them and heating them in closed retorts, was very old. It had been in constant use for the manufacture of carbons for arc lights for I dare say 30 years before. The process undoubtedly has a considerable resemblance. I think the whole of this specification is for arc lighting.

Mr. CHARLES admitted that Scott's object was an arc light.

Sir RICHARD WEBSTER: Is there the slightest indication of a conductor to be carbonised after it had been formed here?—No.

It is blocks or paste, or sticks of carbon which are to be put upon a flexible band, which is made a conductor by having the sticks of carbon put upon it?—I should correct that last answer, I think.

Mr. CHARLES: They are carbonised in Scott's after they are formed.

Sir RICHARD WEBSTER: I think it is not so.

WITNESS: I am not quite sure, I should have to refer to the specification again, as to whether it was possible he had in any way suggested using plastic materials and then carbonising.

Sir RICHARD WEBSTER: I protest that it is not material, but I have no objection to taking my friend's view for a moment. Is there anything in the specification which in any way describes Mr. Edison's arrangement of carbon filament or its production?—Clearly not. There is no limit of carbon filament. It is perfectly clear this is arc lighting throughout.

Mr. JUSTICE BUTT: Yes, I think that is absolutely clear from the language. There is a portion of the specification which speaks of making hollow cylinders of the plastic mass and apparently making it of a mass which is not carbon, and then converting it into carbon, or what they describe as a substance composed of nearly pure carbon afterwards. The suggestion as I I understand it here is, no matter whether for an arc or any other lamp, that you have a conductor of some sort made of a substance which is not nearly pure carbon converted after manufacture to that which is pure carbon.

Sir RICHARD WEBSTER: Of course, your lordship knows already that our case is that even if that be the meaning of this, it is no anticipation in any way of our own patent. [To witness]: Do you understand that those hollow cylinders there described either

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have or would have the same electrical functions as the filament conductors of Mr. Edison ?—Clearly not. There is no resemblance in their electrical functions.

Now I will call your attention to the specification of Mr. Charles Weightman Harrison, No. 3,470 of 1878 : "My invention relates secondly to the production of flexible carbon or flexible metallised carbon burners of any required thickness or length. This I effect by using threads or filaments of silk, cotton, or other suitable flexible material, which I first treat with acid, such as nitro-sulphuric acid, to render it more perfectly combustible, and then coat with carbon or metal by rubbing, pressure, or otherwise incorporating with them powdered plumbago or other carbon, or with metal compounds by electrotype or other process, and then form such coated or treated strands into a cord or rope of any required dimensions." Do you find anything there describing either Edison's conductor or the mode of preparing it ?—No. He does not seem to address his mind at all to the production of a conductor of small cross-section.

Does that relate to arc lighting ?—Yes, I believe it does throughout; and at line 35 it is clearly the arc which he is referring to.

Mr. JUSTICE BUTT : The more important matter to my mind is this : there is nothing describing a conductor of small cross-section ?—No, there is not; it must have been a conductor of very considerable cross-section.

Sir RICHARD WEBSTER : He proposes to act upon it with acids, such as nitro-sulphuric acid. What would that make ?—You would get a compound of cellulose, or whatever the organic matter was, with the nitrogen and oxygen of the nitric acid.

That would not be a very useful light ?—It contains within itself the elements of its own destruction. As soon as it reached a certain temperature, the compound being exceedingly unstable, there would be a sort of mild explosion. There would be a change and then combustion would occur. There would be an end of the filaments. He proposes to burn out the filaments and leave the rest, as I understand.

Would the giving of these descriptions lead anybody to make the combinations as described by Edison ?—No, certainly not.

Mr. JUSTICE BUTT : Neither any of them nor the whole of them together ?—No, I do not think they would help him at all.

Sir RICHARD WEBSTER : Did you ever see or hear of any practical commercial carbon incandescent lamp prior to Mr. Edison's specification ?—No.

Had arc lighting before 1879 arrived at a very fair point of efficiency ?—Yes; for a large variety of purposes.

They had been used to light public places, for instance ?—Yes; for many places. The Jablochkoff candles were used on the Thames Embankment before 1879.

Had the fact that a small sub-divided lamp was required been engaging the attention of the electrical scientific world for a very considerable time ?—Yes. Many people had the impression that it was a thing which could not be done. Mr. Edison and Mr. Swan were both known to be working upon it.

Now I will ask you one or two questions about Swan's lamp. Is this (hands lamp to witness), or is it not, the same as Mr. Edison's combination ?—No. I should not call that a filament.

In your opinion was that carbon before it was formed into shape ?—I should think so. I should think it has been reduced.

Would it indicate a low resistance ?—Yes. I should guess it to be between one and two ohms resistance, perhaps not exceeding one ohm. The platinum conductors also correspond with the view of such a resistance; they are very much stouter than would be used in an incandescent lamp at the present day.

Do you believe it was made in accordance with Mr. Edison's specification ?—No, I do not.

Given that lamp put into the hands of a workman to make a lamp, would that lamp be, in your opinion, any guide to him to produce the combination which you find described, and which you yourself have explained as shown in Edison's specification ?—No; in my judgment it would not be, inasmuch as it neither gives a hint of a filament nor of a mode of manufacturing a filament.

That lamp was shown in December, 1878. As far as you know, did it ever go to any practical result beyond the production of that lamp ?—Not that I know of. As far as I know it was regarded purely as a scientific matter of interest, but not of any commercial importance whatever.

It was not patented ?—No.

And led to no further step in the development of the science ?—No.

We will now pass to Swan's patent, No. 18 of 1880. What do you find to be the invention described in that specification ?—Mr. Swan first points out the difficulties which his invention was required to obviate, evidently referring to incandescent lamps, possibly similar to the one I have just been looking at. What he says the difficulties were are these :—First of all that the carbon conductor, as used, gradually wasted and ultimately broke. That, in fact, was no doubt due to two causes. One of those causes was a kind of wasting by residual gas, no matter what that residual gas might be; the other, no doubt, was due to the fact that carbon is combustible, and that in the residual gas there would be oxygen, and the carbon would combine with that oxygen, forming carbonic acid or carbonic oxide, which would again break and deposit the carbon elsewhere, or at all events would reduce the carbon and cause a degree of waste. The second evil was this, that owing again to the presence of a certain quantity of gas the interior surface of the globe became blackened or dulled. Then he addresses himself to removing those defects, and the way in which he does it is by perfecting the vacuum. The cause of the imperfection of the vacuum was the gas occluded by the carbon escaping out, and he obviates the evil by heating the carbon electrically to as high a temperature as, or a higher temperature than, would ever be used, and at the same time exhausting the gases so driven out, and, finally, in order to render the state of things permanent, he seals the globe.

Before asking you as to the novelty of that I think it only right to call your attention to No. 2,402 of Edison's. What sort of a lamp was Mr. Edison describing there ?—He was there endeavouring to make an incandescent lamp in which the conductor was platinum or platinum iridium.

And in order to improve that lamp what does he disclose ?—He finds that platinum or platinum iridium, if suddenly heated to a high degree of incandescence, develops cracks in the surface, and he attributes that result to the presence of occluded gases suddenly bursting forth, owing to the high temperature. He proposes to obviate that by first of all heating the platinum or platinum iridium to a comparatively moderate temperature in vacuo, and exhausting any gases driven off from the receiver in which it was placed; then heating it again to a higher temperature, and again exhausting or continuing the exhaustion, and so on, until the platinum attained an exceedingly high temperature; and in that way, he says, he alters the character of the platinum in a very great degree.

Was Edison's object to improve the platinum or to improve the vacuum ?—His main object was to improve the platinum, undoubtedly; that is the prominent thing that he throws forward.

Referring to the passage : "Carbon sticks may be also freed from air in this manner, and be brought to a temperature that the carbon becomes pasty, and if then allowed to cool, is very homogeneous and hard," you understand that homogeneous and hard as referring to the substance of the carbon, I suppose ?—Clearly.

What do you understand to be the object of the treatment of the carbon sticks there ?—As I understand this, having explained the physical facts upon which he bases his invention, he goes on to tell us, as another interesting physical fact, that carbon may be treated in the same way; but I see no indication that he proposes any practical application of carbon so prepared.

Mr. JUSTICE BUTT : Then it ought not to have been here, in fact ?—I have often seen in specifications interesting physical facts put forward to which no claim has been made.

Sir RICHARD WEBSTER : At any rate, its importance is with reference to the homogeneity and hardness of the carbon, and not of any air or vacuum surrounding the carbon ?—No; he refers there to no question of vacuum.

Do you think that would be an indication to any electrician that an electric lamp with a carbon conductor would have its vacuum improved by that treatment ?—It is difficult to say how far it might be suggested to his mind; but it certainly calls no attention to the fact that carbon is acted upon by the residual of gas in a different manner from platinum.

The second claiming clause is : "The method herein described of preparing metals and metallic conductors for electric lamps or burners, consisting in freeing the metallic conductors of gases in a vacuum, and then hermetically sealing the surrounding air-tight transparent case, substantially as specified." Given Swan's specification, and, of course, Edison's later specification, 4,576, not to be existing, and assuming that in December, 1879, anybody had thought to make an incandescent lamp with a carbon conductor in it, do you think Edison's specification 2,402 would have led them to have exhausted under an electrical current with a view to improve the vacuum ?—It is possible it might have been suggestive in that direction.

Until Swan's publication in England in that specification, you know of no publication of the desirability of it as applicable to a carbon lamp ?—No.

Is it easy sometimes to read specifications in the light of subsequent knowledge in a way in which they would scarcely be interpreted without ?—The greatest difficulty is, in reading a specification many years after its date, to carry one's mind back to the state of knowledge at the time when that specification was first filed.

With regard to Gimingham's patent, I do not think you yourself have broken a Woodhouse and Rawson lamp or examined the junction ?—No; I have made no further examination than was possible through the glass.

I will only ask you, then, as to the subject matter of novelty. It consists, as we know, of flattening the platinum into a spade-like shape, and turning it round into a socket and putting the carbon conductor in. Do you find anything like that in any previous specification ?—No.

By virtue of this socket, could you get a longer length of the carbon in contact with the metal of the platinum ?—Yes; you get an extended contact of the two bodies.

Do you think it would require thought, research, and experiment to think out such an arrangement, in the first place ?—It would certainly require thought. The thing is simple, and I think beautiful, from its simplicity.

Cross-examined by Mr. CHARLES: But still, is it not the adaptation of an ordinary mechanical device to join the platinum and the filament ?—I do not recall any similar mechanical device precisely. I daresay they may exist, but I do not recall them at this moment.

Now, with regard to the other patents, do I understand you that prior to Edison's patent the filament was not shaped before carbonisation ? I mean that the knowledge that the filament could be shaped before carbonisation was not in existence before Edison's patent ?—That was new, I think, at Edison's time.

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Let me draw your attention to a passage from M. Sidot's lecture on the "Action of Carbon Disulphide and Carburetted Gases on Wood Carbon," the date of which is March 21st, 1870: "In a preceding work I have shown that carbon disulphide was decomposed by carbon, that this last increased in weight, and that sulphur was set free. In following up these enquiries, I had examined what effect carbon disulphide has on certain organic bodies of nature both vegetable and animal. I introduced into a porcelain tube little pieces of wood, across which I began by passing the vapour of carbon disulphide in a cold state in order to expel all the air of the tube. This first result being obtained, I heat the tube slowly and gradually up to a red heat for the space of about an hour. When it has cooled, we find in the tube sticks of a carbon differing in their physical properties from ordinary carbon. The substances of the most different woods, such as box, ash, elm, lilac, alder and cork, can make this new carbon. What especially distinguishes it is its ringing sound, very like those bodies which are considered the most sonorous, such as steel, silver, aluminium, crystal, &c. I have the honour to submit to the Academy some specimens of these sonorous carbons. When we suspend one by means of a thread and strike it on the top it gives a metallic sound. Wishing to obtain with this carbon a sonorous effect, I turned a bell in ash wood and submitted it to the action of carbon disulphide according to the process which I have just described. This piece of ash has now become a bell, which I also present to the Academy; it gives out a sound similar to that of a metal bell of the same diameter. . . . . . The same carbons, which are distinguished so completely by their elasticity from ordinary carbons, differ also from these last in their great conductibility for heat and electricity I believe that they would perhaps replace the carbons of the Bunsen battery. Pencils made from this give a much more intense electric light than that which we obtain from gas retort carbon. The carbon conductor becomes heated in the same manner as a metal and becomes gradually incandescent over its whole surface without breaking into a flame at any single point, like ordinary carbon. It becomes cool immediately we remove the heat. We can characterise its conductibility by saying that it is wood carbon transferred into coke. I have obtained similar results with thread, hemp, cotton, paper and silk. The carbon which I have obtained from wood possesses the metallic sheen, but this polish is only superficial. It has a greater density than wood carbon; it does not absorb gases more readily. I should observe with regard to this, that in heating the wood to a high temperature in a crucible filled with finely-pulverised wood cinders we obtain a carbon deprived of its absorbing properties and a much better conductor. Carbon disulphide is not the only agent of this remarkable transformation from wood into a carbon sonorous and conductive. Spirit of wood, carburetted hydrogen, &c., also change wood into carbon, elastic and conductive. Still more, I have proved that in passing the vapours of methylated alcohol over wood at a red heat in a porcelain tube, this vapour becomes decomposed, and at the same time the interior sides of the tube are covered with a very singular carbon. This carbon, in fact, presents itself in the form of filaments one centimetre in length, constituting a kind of silky and frothy coat, white, like silver. These filaments appear to be formed of little balls touching one another." First, to go back to the last paragraph but three, you see that this writer says he has obtained similar results with thread, cotton, hemp, paper and silk. Is not that a statement of similar results having been obtained from filaments before carbonisation?—What I understand there is that he proposes to heat these in a liquid or gas containing carbon and to deposit carbon upon them, at the same time carbonising them, no doubt.

Then he would shape them before carbonisation?—They would take some shape, no doubt.

And indeed he can select the shape they shall assume before carbonisation?—No doubt he could select the shape.

Mr. JUSTICE BUTT: Does he propose to carbonise these in the strict sense of the word; that is to say, to convert them into carbon?—No doubt the effect of the heat would be to reduce them to carbon, but at the same time you would deposit certain carbon upon their surfaces. To what extent he proposed to carry that is not disclosed.

Does he reduce the thing itself to carbon? That is the point.—Undoubtedly he would reduce the thing itself to carbon.

Mr. CHARLES: So much for Sidot. One word about Scott. It is quite true Scott's patent was for arc lighting, but is it not the fact that he, too, shapes the rods before carbonisation?—Certainly; he shapes objects and then carbonises them.

Now with reference to the word "filament." If I understood your answer to Sir Richard Webster, you do not consider that that substance inside the Swan lamp is a filament?—No.

Then do you confine the word "filament" to thin wire, a thinner wire than that, or what?—I am not prepared to say the precise dimensions at which a filament begins, but I understand the word "filament" to be used for the purpose of calling attention to the smallness of the cross section which is desired in comparison with the length.

Let me draw your attention to a lecture of Mr. Swan's, delivered at the Royal Institution in March, 1882, when Sir Fredk. Bramwell was in the chair. In that lecture occurs this passage: "It will be readily understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fills this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses the other necessary quality of low conductivity or high resistance. The substance is carbon. . . . . In the first incandescent lamp the vacuum was made by filling it with mercury and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer. In the lamp subsequently proposed the air was exhausted by a common air pump. The invention of the mercury pump by Dr. Sprengel and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and gave quite a new meaning to the word vacuum. It was evident to me that the whole incandescent carbon lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon its durability in a really high vacuum required still to be tested. Strongly impressed with this idea, I proposed to Mr. Stearn, who was working on the subject of high vacuo, the carrying out of a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper and made incandescent in a high vacuum was durable. After much experimenting we arrived at the conclusion that when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass bulb, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness. This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea, and reached the same conclusion as Mr. Stearn and myself. A condition of the higher vacuum found to be necessary was the simplification of the lamp. In its construction there must be as little material as possible, and especially there must be nothing in it capable of giving out gas of any kind. There must be no joints, except those made by the glassblower. Therefore, naturally and of necessity the incandescent carbon light took the most elementary form, resolving itself into a simple bulb, pierced by two platinum wires supporting a filament of carbon. Probably the first lamp having this elementary character ever publicly exhibited in operation was shown at a meeting of the Literary and Philosophical Society of Newcastle in February, 1879." It would seem, therefore, that Mr. Swan differs from you with regard to that piece of substance being a filament?—Possibly he may, but I am not absolutely clear as to what he means by this last passage.

Mr. CHARLES was proceeding to cross-examine with respect to this lecture of Mr. Swan's when

Mr. ASTON objected that this was not evidence, as it had not been proved that the words were those used by Mr. Swan.

Mr. JUSTICE BUTT: Assuming that those words were uttered by Mr. Swan, what question do you propose to put on them to this witness?

Mr. CHARLES: The question I propose to put is this: Having regard to the fact that the inventor describes that bar as a filament, what reason can you give for saying it is not one?

Mr. ASTON: I object on this ground, that the statement made by this gentleman in 1882 about what took place in 1878, and his view at that time as to what term should be applied to something, which, of course, he was very desirous of making out that he had invented, is no ground for asking.

Mr. JUSTICE BUTT: My impression, Mr. Charles, is that all you have a right to ask is this: "Have you read this? Assuming Mr. Swan to have said that, do you agree with it?" You have a right to read the passage, and say: "Do you agree with that, and if not, why not?"

Mr. CHARLES: I think that is what I did put. (To Witness): Will you give my Lord any reason for disagreeing with Mr. Swan's views?—I am not quite clear that Mr. Swan does mean to convey that that carbon in the lamp I have been looking at is a filament.

He calls it a filament?—I am not quite sure about that even. I take it he is calling emphatic attention to the fact that the bulb is entirely of glass. If he does mean to call that a filament then I disagree with him, certainly.

Mr. JUSTICE BUTT: "It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness." In seems quite clear to my mind that that is not a filament of extreme thinness in the lamp you have got.—Certainly not.

Mr. CHARLES: I do not say it is. But he says: "Probably the first lamp" (that is a simple bulb pierced by two platinum wires, supporting a filament of carbon) "having this elementary character ever publicly exhibited in operation was shown at a meeting of the Literary and Philosophical Society of Newcastle."

Mr. JUSTICE BUTT: It does seem to me he calls that very thing a filament.

Mr. CHARLES: Where do you stop calling a thin substance a filament? Is it a mere matter of degree?—Clearly, it is a matter of degree.

Mr. JUSTICE BUTT: I think the question we agreed upon was this: Mr. Swan calls that identical thing in the lamp you have before you a filament. Do you agree with him that it is properly called a filament?—Certainly not.

If not, why not?—Because the section is comparatively considerable as compared with anything I have ever heard the term filament applied to. There is no sensible degree of flexibility about it.

Mr. CHARLES: Then it becomes a question of degree?—Yes, certainly.

Mr. ASTON: Your lordship has a description of that identical conductor in the paper to which your attention was called before. In December, 1879, it was called a rod of carbon.

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MR. JUSTICE BUTT: That is a rod you may pickle until your time comes.

MR. ASTON: The description given when the lamp was shown is more important than the description given in 1882.

MR. JUSTICE BUTT: It is undoubted that Swan did call it a filament?

MR. CHARLES: Mr. Edison himself describes the substance as filament, thread, strip, and wire. I think he uses them all. I am sure he uses the first three. Would you call that a strip (handing a large Edison lamp to witness)?—Yes, I think that would be a very good description of it.

I pointed out just now that M. Sidot had said that he could treat threads, paper, hemp, cotton, and silk, in the same manner as he treated the other substances he alluded to in the extract. There is another question I ought to have asked upon that extract. In the last paragraph he says: "I have proved that in passing the vapour of methylated alcohol over wood at a red heat, in a porcelain tube, this vapour becomes decomposed, and at the same time the interior sides of the tube are covered with a very singular carbon. This carbon, in fact, presents itself in the form of filaments of one centimetre in length, constituting a kind of silky or frothy coke, white like silver. These filaments appear to be formed of little balls touching one another." Is the method which he here discloses a practical method of getting a high resistance carbon?—Do you mean a carbon of high specific resistance?

Yes?—No; he distinctly says it has an exceptionally low specific resistance in an earlier passage: "The same carbons are as much distinguished by their elasticity from ordinary carbons, and are distinguished still more by their great conductivity for heat and electricity."

Is it not by virtue of the small sectional area that this carbon filament of Mr. Edison has a high resistance?—Yes; that is why I asked you whether you meant high specific resistance.

Could you not manufacture a filament similar to that and a filament of high resistance (not specific resistance) in the manner pointed out in the last paragraph of M. Sidot's paper?—I very much doubt it. I do not think you would get anything like uniformity. One of the points on which Mr. Edison lays stress, if I remember rightly, is that the filament should be tolerably uniform.

Could not the want of uniformity be provided against by preparation of it before carbonisation?—That I doubt, if carbonisation were conducted as here described. The carbonisation as here described must be conducted in disulphide of carbon vapour.

Now turn to Edison's patent, 4,576, page 5, claim 1: "The electric lamp for giving light by incandescence consisting of a filament of carbon of high resistance made as described and secured to metallic wires." Now I understand you to say that in your view that first claim is for the combination of the carbon filament of high resistance made as described, that is as before described, and secured to metallic wires as set forth?—Yes; for the particular purpose of forming an incandescent lamp.

Have you seen any of the plaintiff's lamps manufactured?—I have seen Mr. Edison's lamps manufactured.

Look at that other patent, No. 5,127. Do you see there that Mr. Edison, on December 15th, filed another provisional specification for an improvement in the process of manufacturing the carbon filament?—Yes.

Will you look at the mode in which he says he has secured that improvement in the process of manufacturing the carbon filament. He first of all makes use of paper, cuts it out, cuts a narrow strip in the form of an elliptical bow, and then treats a number of those pieces of paper in the bottom of a mould of wrought iron, laying a light weight on them in the form of a flat piece of gas retort carbon; he interposes tissue paper, closes the mould, raises the mould to 600 degrees, Fahrenheit, then allows the volatile portions of the paper to pass away, and at the same time the mould retains the paper in its proper shape. The paper is prevented from curling up, and then the mould is placed in a furnace and heated to a white heat, and then allowed to cool gradually. Is that the way in which you have seen the manufacture?—Not exactly. What I saw was the bamboo filament made.

Was the carbonisation conducted after a similar method?—There was a considerable similarity. There was a number of them packed into a comparatively small compass, so that a large number of filaments could be put into the furnace at once.

Now turn to the other patent. "Made as described." There are a good many ways, I see, which are not described, but indicated. There are a good many ways of shaping a filament mentioned?—Yes.

But there is no mode of carbonising described, is there?—He does not go into detail about that, but he tells you that it is to be put into a closed chamber at a high heat.

I do not think so. We will follow that out. At page 3, line 44, you will see this: "I have discovered that even a cotton thread, properly carbonised, and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures." So far with regard to cotton thread properly carbonised. Then: "If the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled," then so on, and so on. But I find no mode of carbonisation shown for the cotton thread, or indeed for the thread coiled in the spiral. "If the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled," and so on.

(The Court then adjourned for the day.)

Wednesday, May 12th, 1886.

Dr. JOHN HOPKINSON, recalled, and further cross-examined by Mr. Charles: Would you please turn to M. Sidot's paper again for a moment? The question I want to put to you is, whether by the means described in this last passage of Sidot's paper it is not practicable to get a carbon filament of high resistance?—I think not.

Why not?—These apparently go nothing beyond a centimetre in length, and they are filaments in a different sense from those which Edison describes, inasmuch as that they are not uniform in section, being composed of little balls in contact with each other.

Are there not incandescent lamps in existence with filaments of less than a centimetre in length?—Yes. Whether you call them filaments or not, I am not quite sure. The lamps I have in mind I should hardly speak of as having filaments.

Take, for instance, the lamps which illuminated the gardens at the Inventions Exhibition last year. Were they not incandescent lamps with a filament about a centimetre in length?—I do not think I have seen one close, but my impression is they would be more.

MR. JUSTICE BUTT: Taking your translation of this as it stands. I am not quite satisfied it is right. If you take, say, half-a-dozen marbles, and put them down on the desk touching one another, that would be a filament according to his description of it here, if it is rightly translated as formed of little balls in juxtaposition.

MR. CHARLES: I think the translation is correct, but I am imformed that the filament in question would be perfectly uniform.

MR. JUSTICE BUTT: How could they be perfectly uniform if they were composed in that way? I do not see how that could be.

MR. CHARLES: I shall be able to show that the balls which touch each other are the infinitesimal molecules.

MR. JUSTICE BUTT: That is why I said I doubted whether it was a correct expression. I daresay it is literally correct, but it does not convey to one's mind what the writer means.

MR. CHARLES: I will now pass on to where we broke off yesterday. Go back, please, to Mr. Edison's patent, 4,576. Do you find anywhere in that patent any description of the method of carbonisation, except in reference to spirals?—No. In both cases in which he speaks of carbonisation in a closed chamber he refers to spirals.

Re-examined by MR. ASTON: Your attention was called yesterday to a statement made by Mr. Swan in a lecture delivered at the Royal Institution in March, 1882. In that lecture your attention was called to the fact that Mr. Swan, in speaking of certain lamps of his, referred to the carbon as carbon filaments. I will read to you what Mr. Swan said at a meeting in February, 1879: "Among the many uses to which the electric light was put, he mentioned the lighting of Sir William Armstrong's picture gallery at Craigside, Rothbury. In the abstract of a report of two engineers on the cost of working for a month on a small scale the Jablochkoff candle system at Westgate-on-Sea, the relative cost of electric light and gas light was put at 4 to 1. . . . . What was required to make street lighting and shop and house lighting successful was an electric lamp in which there was no waste of carbon and no waste of machinery. Mr. Edison said he had invented such a lamp; Mr. Sawyer said he also had. If this were true, and if along with these advantages those lamps gave a satisfactory return in light for the electricity spent, then the chief problem was solved, and they would not have to wait long for a very extended development of electric lighting. But, in any event, even if it should happen that those inventors had not accomplished quite as much as we have been led to expect, the problem of a simple and economical lamp would, he did not doubt, be ultimately solved, and with its solution electricity would become a means of illuminating." Then, in December, 1879, Mr. Swan says: "At a recent meeting of the society Mr. Barnard Proctor read a short paper 'On the Smoke of an Electric Lamp.' It will, I believe, be remembered that the lamp referred to consisted of a globe of glass (about three inches in diameter) containing a rod of carbon. The rod was ·04 of an inch in diameter and 1·2 inch long. It was held in a central position in the globe by sockets of platinum attached to platinum wires, which passed through opposite sides of the globe and were hermetically sealed in it. The globe was carefully exhausted of air by a Sprengel pump. A current of electricity had been passed through the carbon rod, which raised it to a state of intense incandescence, and even bent it in such a manner as even suggested that it had perhaps been softened by the intense heat. After the lapse of about a minute, during which a light was emitted sufficiently brilliant to illuminate a room about 40 feet square, the intense heat to which the carbon had been raised communicated itself to the platinum sockets and melted them, and so caused an interruption of the electric current and extinction of the light. When the globe came to be examined it was found to be coated with a deposit having the appearance of carbon, but as it was difficult to imagine how carbon had got there it was desirable that it should be proved whether it was really carbon or not, and my friend, Mr. Barnard Proctor, took in hand to examine into the nature of the deposit. The result of that examination has already been laid before you, as I have mentioned, and you will remember that the deposit proved to be for the most part carbon. That was one point settled. Another point which remains to be settled was the question how the carbon deposit got where it was found, whether, contrary to common

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belief, carbon was volatile, or whether its transport could be explained in any other manner. The object of my notice is to state that this last point has also been settled. Experiments which I, with the co-operation of my friend, Mr. Stearn, have recently made conclusively proved that the deposit, which occurs under the conditions described, is due to the mechanical transport of carbon particles, the residual air contained within the globe being the medium. We find the less air there is left in the globe the less deposit to take place; and we have succeeded in so nearly exhausting some globes that no deposit whatever takes place after a long continued ignition of the carbon rod."

Mr. JUSTICE BUTT: Does that mean that the carbon was volatile or not?

Mr. ASTON: It was either volatile, about which there may be some doubt, or else owing to the action of any residuum of air that was left; the air is in a continual state of what Mr. Crookes calls bombardment, and it may have been by the action of the atmosphere, the particles being detached from the carbon rod, carried by the air and deposited on the surface.

Mr. JUSTICE BUTT (to Witness): Would you describe that as volatile?—No. As I understand, what Mr. Swan here means to convey is that his experiments show that the transference of carbon to the walls of the reservoir is not dependent possibly on the heat, but depends also on the presence of some quantity of gas, and that therefore the gas must be regarded as in some sense conveying the carbon.

Mr. JUSTICE BUTT: I should like to know whether it meant that carbon is or is not volatile.

Mr. ASTON: I think Mr. Swan was taking the view that it was not volatile.

WITNESS: I take it he means in this case the fact was not due to any volatilisation of carbon.

Mr. ASTON: Having had your attention called to those two expressions, what do you say is the carbon which was shown in the lamp here yesterday?—He says distinctly here that in the two lamps which he had shown the carbon was a rod a 25th of an inch in diameter and about an inch and a fifth long.

Under those circumstances, would it have a certain amount of rigidity?—Undoubtedly. Its flexibility would be almost insensible.

If it were rigid, and held at the two ends, would there, under heat, be an expansion and contraction of the rod?—Yes.

What would be the result of that, do you think?—It would undoubtedly tend to bend it or else to bend the wire.

Would that contribute to the efficiency of the lamp?—No.

What would have been the result of the expansion and contraction of that rod, which would have a certain amount of rigidity?—There would be a tendency to its destruction mechanically. Whether that was the cause of the destruction, I do not know.

Have all the filaments described by Edison flexibility and resiliency?—I should expect to find it in every case to a sensible extent.

I understood you to tell my lord yesterday that those are qualities which enable a lamp to be moved about with reasonable safety?—Yes; they no doubt are valuable in that respect.

Bearing that in mind, what do you say with regard to whether the carbon used in the Swan lamp is or is not such a thing, whatever the thing may be, as what Edison calls a filament in his specification?—I do not know that a rod of carbon the 25th of an inch in diameter and 1·2 inch long would be described by anyone as a filament.

Is it such a thing as Edison in his specification describes as a filament?—Most certainly not. He there gave some idea of the dimensions, which are very different from these. Nor would it have such an electrical resistance as he indicates.

Now, your attention was called to certain extracts which set out part of a paper of M. Sidot, taken from the *Comptes Rendus*. Generally, does Sidot describe any filament such as you find described in Edison's specification?—No. The real point of Sidot's investigation is the deposition of carbon from a gas or vapour containing carbon, by heat. That is apparent from the last paragraph, in which the carbon is deposited upon the walls of the tube or receptacle in which the gas is contained.

The SOLICITOR-GENERAL: He also describes the carbonising of paper and silk?—He certainly describes the carbonisation of those bodies by the heat, but at the same time there would be a deposit of carbon upon them in an irregular way from the surrounding gas, which would make it quite impossible that in this way a useful filament should be produced.

Mr. ASTON: Does Sidot in any way produce the use of such a filament for an electric lamp?—He speaks of using, not the filaments, but crayons produced by this process, as I gather, for arc lighting.

The SOLICITOR-GENERAL: He says: "It becomes gradually incandescent over its whole surface." Does not that show that what he had in his mind was an incandescent lamp?—I think not. I think he is there referring to the conductivity of the material for heat being similar to a metal, and therefore if you heat it in one point the heat will be conducted all over.

Reading these words: "This carbon conductor becomes heated in the same manner as a metal and becomes gradually incandescent over its whole surface without breaking into a flame at any single point like ordinary carbon." Would not that point an experienced person to a material useful for a burner of an incandescent lamp?—Certainly not, because he refers there to breaking into flame at any point; the fact of referring to breaking into flame would go to show that he did not there contemplate an incandescent lamp with carbon, all of which had been made in a case containing no oxygen or else in vacuo. I am pretty clear in my own mind what that is meant to illustrate. He means there to show that this carbon is a good conductor for heat, and that consequently it would become uniformly heated, and it would be difficult to heat it at any one point.

I will not agree with you. I also ask you this, whether Sidot's filaments, made from cotton, paper and silk, are not described as elastic and conductive?—Yes.

And to that extent would they not have the same distinctive qualities as my learned friends insist on with regard to Edison's filament?—They would have the properties of being elastic and conductive undoubtedly; or he says so, at all events.

Dr. JOHN AMBROSE FLEMING, Professor of Electrical Technology in University College, and electrical adviser to the plaintiff company, was next sworn. He said he agreed substantially with the evidence given by Sir Frederick Bramwell. An electric lamp such as Edison described was new at the date of patent, 4,576; prior to that date he had never seen nor read of a filament, such as Edison described, being used. The specification would enable an ordinary skilled workman to make such a lamp as described. He could call to mind no incandescent lamps that were used practically which contained a rigid carbon pencil or rod. In a rigid rod there was an absence of that flexibility or elasticity which is essential to enable the carbon to accommodate itself to changes of temperature, and it would not, therefore, be suitable for an incandescent lamp. Opinions differed as to what the actual temperature of the carbon in an incandescent lamp was, but it was generally assumed to be something near 2,000 degrees centigrade. He had recently made some experiments with a Swan lamp, of the kind relied upon by the defendants as being an anticipation. He first of all verified, as far as possible, the dimensions of the carbon, which was not according to his view, a filament properly so-called. He next endeavoured to ascertain the electrical resistance of the lamp, expecting to find it something small, but in its then condition he found it very high and uncertain, variable. The inference he drew was that there was a variable contact at the place where the carbon rod was joined to the platinum wire, and this variability of contact, he concluded, had been produced by the expansion and contraction of the carbon rod when the lamp was used for the first time. The carbon rod, being rigid, would expand when heated, and unless it bent it would probably deform the platinum wires, or render the contact uncertain; if there were a good connection there would be a low resistance. These experiments indicated that that form of lamp would not be a form adapted for commercial use. He knew of no such lamps now in use. He also made an examination of one of the defendants' lamps, and compared it with those of the plaintiff company. The platinum terminals of the defendants' lamp were constructed in the manner described in Gimingham's specification. The wires were first of all apparently flattened out, and then bent round into two small tubular clamps, into which the carbon filaments were inserted. At the date of Mr. Gimingham's patent, September 29th, 1881, those means of effecting the junction were, so far as he could say, new.

Cross-examined by the SOLICITOR-GENERAL: I observe that you answered my learned friend Mr. Aston's question that you had never known of a filament such as Edison describes in his patent being used in a closed vessel of glass, and so forth. I presume you refer to such as Edison describes in his patent which is being sued on, No. 4,576?—Yes.

Will you point out to me in Edison's specification the passage in which you say that he describes the filament, because we are unable to find it, I tell you honestly, in the final specification?—I think it is described in the final specification, page 3, lines 44, and onwards.

He says: "I have discovered that even a cotton thread properly carbonised and placed in a sealed glass bulb, exhausted to one-millionth of an atmosphere, offers from 100 to 500 ohms resistance to the passage of the current." That is the statement of what he has discovered?—Read further onwards; the whole of that paragraph.

I will read the whole of the paragraph, but I want, as I am perfectly entitled to do, to break it up. "And that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled that as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch." Is that the passage to which you refer?—That is the passage.

Point out in that passage whether you see what you refer to.

Mr. MOULTON: You ought to read a little further.

The SOLICITOR-GENERAL: I will read where you like, but I am perfectly entitled to stop when I like and ask a question, subject to explanation. "That if such fibrous material be rubbed with a plastic compound composed of lampblack and tar, its resistance may be made high or low, according to the amount of lampblack placed on it. I have also discovered that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty." I ask you in which of the words of that sentence you find a carbon filament described?—In the words on page 3, line 48: "Or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber."

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Now, I will ask you first whether there was any novelty in carbonising a fibrous vegetable substance by heating it in a closed chamber at that time?—Not a mere carbonising.

I am asking you a perfectly definite question: whether there was any novelty in carbonising a fibrous vegetable substance by heating it in a closed chamber?—No.

Now I will ask you further, because I want to understand your evidence, whether you refer to anything else as a carbon filament, such as Edison describes?—The first ten lines on page 4.

That is the lampblack?—Yes.

"I have also discovered that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material"——. I understand that to mean the tar and lamp-black?—Yes. I understand it to mean the tar and lamp-black.

"Small pieces of this material may be rolled out in the form of wire, as small as seven one-thousandths of an inch in diameter, and over a foot in length, and the same may be coated with a non-conducting, non-carbonisable substance, and wound on a bobbin or as a spiral, and the tar carbonised in a closed chamber by subjecting it to high heat, the spiral, after carbonisation, retaining its form." That all relates to the tar and lamp-black exclusively?—I think so.

And the following sentence also relates to it?—Yes.

With the exception of the carbonisation of a fibrous vegetable substance, and the making carbon filaments with tar and lamp-black in the manner described by Edison, is there any other description of a carbon filament such as Edison describes?—I find that he speaks lower down of the carbon wire, line 29.

"When fibrous material is used the plastic lampblack and tar is employed to secure it to the platina wires before carbonising. By using the carbon wire of such high resistance, I am enabled to use fine platinum wires." That is the carbon wire which he has previously been referring to?—Yes.

And the same thing as the carbon filament? He calls it wire in that place?—Yes.

But he does not describe there, does he, any particular form of carbon wire, or carbon filament?—No, except by speaking of it as a carbon wire.

(To be continued.)

Edison and Swan United Electric Light Company, Limited, v. Woodhouse and Rawson.

SECOND ACTION.

(Before Mr. Justice Butt, *sitting in Chancery.)*

This action, which was commenced upon the termination of that the judgment in which we published last week, was for the alleged infringement of Specification No. 4,847, of 1878, a communication to Frederick John Cheesbrough from Messrs. Sawyer and Man, of New York, describing an improved method of charging an electric lamp, the production of a better carbon for use in electric lamps, and for other electric purposes.

Counsel for the plaintiffs, as in the first case, were Sir Richard Webster, Q.C., Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. P. Edward Dove; and for the defendants, the Solicitor-General (Sir Horace Davey, Q.C.), Mr. Charles, Q.C., Mr. Macrory, and Mr. H. G. Rawson.

The witnesses called by the plaintiffs were Sir Frederick Bramwell, Dr. Hopkinson, Mr. Imray, Prof. Dewar, and Dr. Tidy. No witnesses were called for the defence, and infringement was admitted, if the patent were held to be valid.

The Solicitor-General argued that there was anticipation of the process described and the material used by Cheesbrough, quoting papers by Sidot, St. Edmé, and Despretz in support.

Mr. Justice Butt delivered judgment on Tuesday as follows: The plaintiffs in this action are the owners of a patent, No. 4,847, dated November 28th, 1878, as amended by disclaimer of November 12th, 1884. The claim is against the defendants for the infringement of that patent. The patent is one for making the carbon conductors of electric lamps. The process by which the desired result is obtained is, to my mind, one of singular beauty and efficacy. The principal features of that process are these: a pencil of ordinary carbon is immersed in a hydro-carbon gas or liquid, a strong electric current is passed through the carbon, and in the course of its treatment the carbon is subjected to a gradually increased current of electricity. The defects in ordinary carbon for electric lighting, and the remedies applied by his process, are thus stated by the patentee in his specification: "As is well known, carbon suitable for electric lighting by the voltaic arc, is naturally produced in gas retorts, but generally the rods of carbon used in the regulator lamps so called are moulded from the powdered material. Neither the one nor the other quality of carbon is suitable for electric lighting by incandescence. In both there is a lack of homogeneity. The pencil is not sufficiently hard and dense, because in the first place the heat required to produce the proper character of carbon is as high as 7,000° Fahr., and such a temperature is not obtainable in the retort; and, in the second place, the mechanical subdivisions of the material, and the pressure necessary to produce the perfect article are practically unattainable. Carbon of the ordinary sort when heated by the electric current exhibits points and lines of unequal brilliancy. Carbons prepared by this process, when so heated glow with a uniform brilliancy throughout." The principal part of that relates to the objections to the use of the ordinary carbon for the electric light. Now comes the improvement: "It has been found that a pencil of carbon immersed in a hydro-carbon gas or liquid, and heated to an extremely high temperature by the voltaic current is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright gray colour, upon the exterior surface. As the carbon increases in size more current is required to maintain its temperature, and if the current is gradually increased in accordance with the demand for it, there is apparently no limit to the increase in mass of the homogeneous exterior deposit. Carbon pencils may be cut from this deposit, or the original pencil with its coating may be used in the lamps. In this process it will be seen that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of very high temperature; beeswax, balsam, and most oils, if pure, operate satisfactorily, almost any hydro-carbon, in fact, will answer." The peculiar merit of the invention consists in the well-nigh perfect adaptation of the means employed to the end aimed at, and this by the automatic action of the materials employed when subjected to intense heat generated by the passage of the electric current. As pointed out, in an ordinary piece of carbon subjected to a strong electric current, there are observed points and lines of unequal brilliancy. The most brilliant parts are those where the carbon has the smallest sectional area, the resistance of the carbon to the passage of the electric current, and therefore the heat, being in inverse proportion to the size of the cross-section of the carbon. At these points of greatest heat the deposition of the carbonaceous matter by means of the hydro-carbon gas is most active, and so equalises the carbon, which is also made more dense by the operation. That being the patent, I do not understand that there is any serious dispute that, if valid, it has been infringed by the defendants. The answer to the action is, not that they have not used the process or the material in question, but that they have a perfect right so to do, because the patent is invalid, inasmuch as the process by which the material was made was known long before the date of the patent in question. The process and the material were common property, which the public, and they as part of the public, were entitled to apply to any purpose they chose, for electric lighting by incandescence amongst other things. The question arises, therefore, was this process known before Cheesbrough's specification? That appears to me to be the principal question in the cause, though there are some other objections made by the Solicitor-General to the validity of this patent. With those objections I propose to deal in the first instance. In the first place, a reference was made by the Solicitor-General to lines 5 and 6 of the 12th page of the specification. In stating the objects of the invention the patentee there says, after having detailed some others: "To obviate these several difficulties is the object of this invention. To charge the lamp it is preferred to employ nitrogen gas, and this is produced in the lamp by an improved process in a state of great purity." It is objected that there is no direction in the course of the specification given to the public how to make that improved nitrogen gas. But on looking to the claim, or to that part of it which refers to the passage I have read, namely claim No. 3, I do not see that any claim is made for an improved nitrogen gas. The words of claim 3 are as follows: "3. The hereinbefore described method of preparing the illuminating part of an electric lamp consisting in first obtaining a solid deposit of carbon by electric action as set forth, and subsequently when the globe containing it is charged with a carbon preservative atmosphere, before the flow of such preservative atmosphere through the lamp has ceased and before the lamp is finally sealed, heating the illuminating part by means of the electric current, in order to expel impurities and occlude gases." The nitrogen gas, as I understand it, is there referred to in these words: "It is charged with a carbon preservative atmosphere." And in another part of the specification he states that anybody knows how to get or to make the material used. I point out, in the first instance, that there is no claim, strictly so-called, to the use of the improved nitrogen gas. But at page 14, line 34, these words are used: "The lamp being set up the next important thing is to charge it with the atmosphere, which will prevent consumption of the carbon, and the detailed description of the process of charging the lamp is as follows." Now, before that word "process" he had, in the first instance, the word "improved;" "improved process," it read originally, "of charging the lamp is as follows." Therefore, he struck out that word "improved." But it may be said, and I think it was said: "That is all very well; but that refers, not to the manufacture or the making of the improved nitrogen gas, but to the charging of the lamp." Well, I do not quite agree; I cannot agree that that refers only to the charging of the lamp when the gas is made, because directly afterwards I find this: "The detailed description of the process" (originally it was "improved process") "of charging the lamp, is as follows: The various methods of manufacturing nitrogen gas are well-known. Having dried and purified the gas until it stands all tests, it is passed into a dry receiver, preferably a bag of vulcanised rubber." In starting to describe the charging of the lamp, the very first thing he does is to tell you what gas to use. Therefore, I think the objection, properly considered, really amounts to a little more than a verbal criticism, and there is no substance in it. Secondly, it is said that the patent is void, because it describes various methods of making the

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material, some of which methods will not answer; in other words, that it would mislead the public. The first claim is in these words: "The herein described method of preparing the illuminating part of an electric lamp, consisting of electrically heating the same, while it is surrounded by a carbon gas or liquid." Now, the "herein described method" mentioned in that claim, refers to a passage at page 15 of the specification. It is a passage which I have read once already, but to which I shall have to refer more than once in the course of my judgment. "It has been found," it says, "that the pencil of carbon immersed in a hydro-carbon gas or liquid, and heated to an extremely high temperature by the voltaic current, is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up the pores," and so on. And then further on, line 44, he says: "In this process it will be seen that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of very high temperature; beeswax, balsam," and so on; and then he says: "almost any hydro-carbon, in fact, will answer." We have, therefore, three terms used: he speaks of a hydro-carbon gas, he speaks of a carbon gas and of a carbonic gas; and from the evidence I do not think he meant exactly what he said in using any one of those expressions. Dr. Tidy, I think, said, in answer to the Solicitor-General, that the term hydro-carbon gas, as used by him here, is clearly an erroneous one, strictly speaking, in a chemical sense; because strictly speaking, as I understood the matter, hydro-carbon gas consists of carbon and hydrogen alone, without any other element mingled with it. That is clearly not what the patentee was referring to. I do not know whether very much turns upon that. But when you come to the other two things mentioned, carbonic gas or carbon gas, probably the same thing is indicated. It is said: "But that will include some gases which, if applied, would not produce the result at all. It would not. says the Solicitor-General—and he is warranted in the assertion by the answers he got from Dr. Tidy, and I think one or two of the other scientific witnesses—it would not produce the effect; it would include both carbonic acid and carbonic oxide, and if you used either one of those two ingredients you would fail to get the deposit which you are seeking to get on to your carbon pencil, and your whole operation would fail. Well, if the specification is really to be read as a direction to the public to use either one of those gases, then I should agree that the process, as described, is a futile process, which would be misleading to the public, and that the objection had assumed very serious proportions indeed. But then I do not think he really meant that, and I need not give my own reasons for saying so, because I get them better from the evidence of one or two of the witnesses. In the first place I will refer to what Dr. Hopkinson, in cross-examination, has said: "In the sense I understand the patentee to use the words carbonic gas, which would include carbonic oxide and carbonic acid, carbonic oxide and carbonic acid would not effect the purposes of making the deposit." Then I find Dr. Tidy is examined upon the point, and he is asked with reference to the expression hydro-carbon gas or liquid: "Is that a correct expression?" He says: "From what follows objection may be taken to it undoubtedly, from the strictly chemical stand point, because in strict chemical language we understand by hydro-carbon a body that contains only carbon and hydrogen and nothing else. But I think by the term hydro-carbon in this specification is clearly meant a body that contains carbon and hydrogen. The word is not used to my mind in the chemical sense in this specification, but as a body that contains carbon and hydrogen, though not carbon and hydrogen exclusively. I will make my meaning clear by saying, in all chemical manuals and phraseology we do not speak of oil and beeswax as hydro-carbon, although they do contain hydrogen and carbon." I may here say that beeswax is stated as one of the things that would do for the purpose. "We speak, for instance, of marsh gas and benzole, which has been mentioned before, as hydro-carbon, because they contain carbon and hydrogen only. Therefore, in strictly chemical language, I am prepared to admit that that would be an inaccurate phrase." Then a little further on he goes to the other point. Mr. Aston says: "I should like to ask whether, reading this specification on the principle of fairly understanding it—that is what I mean by a willing mind—would any person be led to try carbonic oxide or carbonic acid?—(A.) No, I should not think so. (Q.) Why not?—(A.) I cannot imagine that anybody would ever dream of trying it. (Q.) Just tell my lord why. Can you not give some popular reason?—(A.) First of all, you could not get any carbon deposit from them by the process that is suggested. (Q.) Would anybody know that?—(A.) Any text book would have told them, I would have thought." Although I am speaking from recollection, I thought I heard him say: "Any sixpenny text book." Perhaps it did not reach the shorthand writer, but I am confident I heard it. When he comes to be cross-examined by the Solicitor-General, he says: "It is not an expression I should have adopted myself. (Q.) Do you not understand by the expression carbon gas, a gas of which carbon is one of the constituent elements? That is the way I should prefer to put it.—(A.) I do. (Q.) Would not carbonic acid be a carbon gas in that sense?—(A.) Yes; in that sense, certainly. (Q.) Would not carbonic oxide in that sense be a carbon gas?—(A.) In that sense, certainly. (Q.) They would come under the description of a carbon gas in that sense?—(A.) In that sense, certainly. (Q.) You tell my lord, from your great knowledge, and of the distinction we all know you are, you are aware that carbonic oxide and carbonic acid would not have the result that Cheesbrough contemplated; the gas being decomposed and the carbon deposited?—(A.) No. (Q.) You know it?—(A.) Certainly. It would not have that result. (Q.) What reason have you for saying that Cheesbrough knew it?—(A.) I can only refer you to what is in the body of the specification." Then there is further discussion upon that, and there the matter, so far, ends. Now, it certainly does appear to me, having regard to the expression used, having regard to Dr. Tidy's statement on oath, which is absolutely uncontradicted, that no man of ordinary knowledge, in his senses, would think of applying carbonic oxide or carbonic acid to this operation—it seems to me it would be an extremely hard and unjust interpretation of this specification to hold that the patentee invited the public to use carbonic oxide or carbonic acid, and so render his patent void. I now come to what I regard as the real question before us. Was this process known before Mr. Cheesbrough's specification? A great number of applications have been referred to by the defendants in support of their contention that neither process nor material was new. I think the only publications requiring serious consideration in this relation are those of M. Sidot, which was made in the year 1870, and M. Despretz, at a still earlier period, in 1849. I will take M. Sidot's paper first. No doubt, in the course of some experiments he was making—not with the view of electric lighting, as I understood it—M. Sidot produced a material resembling that which results from the process patented. But it appears to me impossible, on the evidence, to say that he either described a process that would make the material, or that he did make the material produced by Mr. Cheesbrough's process. The evidence satisfies me that the desired result cannot be obtained by the application of external or furnace heat as contradistinguished from heat produced by electric action as used by Mr. Cheesbrough. Sir Frederick Bramwell, in his evidence, deals with that matter, and I will refer shortly to what he says upon the subject. He points out this in substance, that uniformity of heat produces uniformity of deposit per unit of the area; and that is just what you do not want in your process for producing the carbon conductor described by Mr. Cheesbrough. Then there is a passage of at least equal importance in Prof. Dewar's evidence, to which I will now advert. Prof. Dewar is also asked about Sidot's experiment, and he says: "Sidot's experiment shows that the main deposit at a high heat is on the walls of the tube and not on the wood. (Q.) Very well. Some would deposit on the wood?—(A.) I have no doubt some would. (Q.) Assuming that some is deposited on the wood, are you able to point out any difference in the carbon which has the extra deposit put upon it by Sidot and the carbon which has the extra deposit put upon it by Cheesbrough?—(A.) I do not think they have anything in common. (Q.) Tell my lord why, if you please.—(A.) I have already said that carbon produced by electric action at the high temperature which is pointed out by Cheesbrough cannot be produced by any furnace operations." It must be remembered that Sidot's operation was purely a furnace operation and nothing else, heat produced by fire from the outside. "I have said that all carbon necessarily contains hydrogen, more or less along with other impurities." I asked him: "You say it is not the same material?—(A.) I say it is carbon, more or less, but it is not the same material. I say it is not in the same physical condition." That evidence is wholly uncontradicted.

The Solicitor-General said there was cross-examination upon that point, and the effect of Prof. Dewar's answers was that it was a question of degree.

Mr. Justice Butt: I thought that was Despretz.

The Solicitor-General: No, my lord; it was Sidot.

Mr. Justice Butt: I have a distinct recollection of what he said, but I was under the impression it was in regard to Despretz and not Sidot. However that may be, I think degree has everything to do with the matter here, because in this electric conductor the degree of improvement in making, the degree in which you fill up the pores, the degree to which you give it density, is all important, and if Sidot's will not do it, I do not think Sidot's paper can be called an anticipation. I now come to Despretz's paper, published in 1849. I have no doubt Despretz produced a material in substance very like, if not identical with that used for the carbon conductor patented by Mr. Cheesbrough, and he got the heat he supplied by means of an electric current. But there is one most important object obtained by the process patented by Mr. Cheesbrough, which I think the defendants have failed to show that Despretz's process would yield. The principal object of this patent is to ensure the filling up, in the course of the treatment, of the pores of the carbon, the porosity of ordinary carbon being a serious objection to its use for incandescent lighting. Now one part of the process described in the specification is a gradual increase of the electric currents. This was certainly no part of Despretz's process. Is it an important matter? All or nearly all the witnesses referred to it as a matter of significance. Prof. Dewar says that it is essential to cure the porosity of the carbon. My note of Prof. Dewar's evidence upon this point is as follows: "He (that is, speaking of the patentee) also points out the advantage of a gradual increase of the intensity of the current. For Cheesbrough's purposes you must have an intense electric current increased from a less intense one. I find no direction of all this in the anticipation; that is in Despretz. Despretz used an enormous current, but he put out the whole at once; it was not graduated." Then he goes on to Sidot: "I have experimented with Sidot's process;" and then he refers to those experiments. "I say the carbon produced by Sidot is not the same as Cheesbrough's, not in the same physical condition. I say you cannot get Cheesbrough's carbon from any process carried out by external heating." Then, in coming to Despretz, he says: "There is nothing in Despretz's paper which would suggest its application to the purpose of getting a good carbon conductor

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for an incandescent lamp. I have not the slightest doubt but that the porosity of the carbon was not cured by Despretz's process, because he did not apply the graduated current."

The SOLICITOR-GENERAL said he did not want to interrupt, but his lordship of course remembered that in cross-examinination Prof. Dewar withdrew what he had said in chief, that the graduated current was essential to Cheesbrough's process.

Mr. JUSTICE BUTT: I do not think so. I did not understand him so.

The SOLICITOR-GENERAL: I asked the question: "As I understand, you tell my learned friend you considered the graduated character of the current was essential to the process. Prof. Dewar: Well, I think I may nearly go that length. But you did go that length.—But I did not mean essential in that sense. I will say candidly I did not say essential in the sense that it could not be carried out without it. It would be highly advantageous. I might go as far as that." Then some discussion as to why he used the word "essential," and he says: "I say candidly I did not intend to convey that it was not possible to carry out the process without it. (Q.) But highly advantageous?—(A.) Yes; so highly advantageous as to be almost essential." Further on, he says: "I did not mean to go that length;" that is to say, "as to be almost necessary." I ask him to point out some passage in which Cheesbrough says the graduated current is highly advantageous, and he admits that he cannot.

Mr. JUSTICE BUTT: I have read this evidence, and I am trying to understand it as far as I am able. I read all those passages, and I cannot conceal from myself that in the evidence of many of these gentlemen, in one part and the other, there are discrepancies in the context. But the conclusion to which I have come upon the whole is, that Prof. Dewar, taking the whole of his evidence, examination, and cross-examination, intended to abide by this, that you could not cure the porosity without the gradual increase in the current. If I am wrong upon that point, the defendants will have an opportunity of reviewing the whole of the evidence and setting me right hereafter. At the moment I did not recollect this passage, but I had marked it, and the conclusion I have formed on the whole of the evidence is, that I certainly do not feel that I could come to the conclusion that M. Despretz, in the paper in question, has described a process which would enable a a competent workman to arrive at the result Mr. Cheesbrough has obtained. Had I thought otherwise I should have taken time to consider whether the admitted publication in England—for it is admitted—of M. Despretz's paper would have been what is called an anticipation of Mr. Cheesbrough's invention. M. Despretz's paper is entitled "Volatilisation of Carbon;" it relates to experiments on the volatilisation of carbon, a process the very reverse, as I understand it, of that which an electrician would desire to bring about for the purposes of electric lighting. The material alleged to be identical with that of Mr. Cheesbrough's improved carbon conductor was not a material which M. Despretz was seeking to obtain; it came upon him as a surprise, and as a disturbing element in the course of his experiments, interfered with the achievement of the object he had in view, and its presence does not, certainly, seem to have been regarded by him with any degree of satisfaction. Moreover, his experiment never seems to have been repeated from the year 1849 down to the time of Mr. Cheesbrough's specification, nor during that period do we find the material in question ever applied to any useful or practical purpose. I would here refer to one passage in Dr. Hopkinson's evidence. Despretz's publication, he says, has no reference to incandescent lighting, and would not be a publication to which an inventor of an incandescent lamp would turn; when he saw the title of that paper it would rather deter than invite him to look into it. I am, therefore, of opinion that the invention which Mr. Cheesbrough patented had not been anticipated by any prior publication of this process, that the patent sued on is valid, and, as its user by the defendant is admitted, there is infringement, for which the plaintiffs are entitled to relief.

Mr. ASTON made the usual application for an injunction in terms, an account of the profits, the delivery up of the infringing articles, subject to any arrangement which might be made between the solicitors of the parties, and for costs on the higher scale.

His LORDSHIP acceded.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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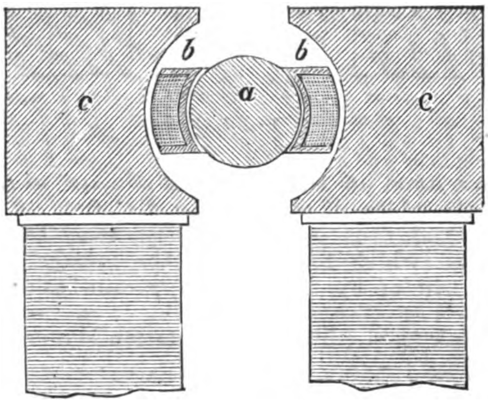
(*Continued from page* 469.)

THERE is still living in America a well-known scientist, Professor Rowland, who has also done much in a quiet sort of way in experimenting in the direction of developing the dynamo. It appears, however, that his researches were not made public, and the only record thereof exists in a note book which a Mr. Arthur S. Hathaway, more than a year ago, found in Prof. H. A. Rowland's library at Johns Hopkins University. This contains some very interesting information in regard to the dynamo-electric armature made by Prof. Rowland in 1868–9, and quietly exhibited by him at the Electrical Exhibition in Philadelphia in 1884.

Mr. Hathaway found it in a book "used while a student in the Newark Polytechnic Institute, 1868." Under date of August, 1868, is the following:—

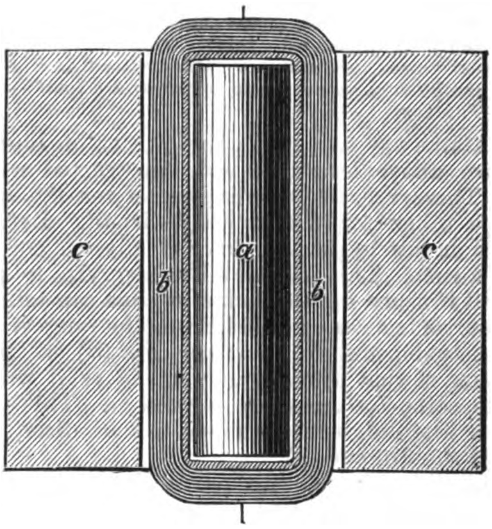
"Magneto-Electric Machines.

"In all forms of these machines yet made, a revolvable armature of iron is used. Now, it is well known that a large portion of the power used to drive these machines is absorbed in producing heat and currents of electricity in these armatures; therefore, I propose either to form them with wire, or dispense with them altogether. The figures show an arrangement for effecting the latter.



ROWLAND'S ARMATURE.

"The armature, a, is held stationary, while the coil, b, b, revolves around it, thus cutting lines of magnetic



ROWLAND'S ARMATURE.

force. By this arrangement, all the power will be used to produce a current in the coil, while in the ordinary form the armature has to be magnetised and demagnetised rapidly, thus absorbing power. This arises from the resistance of iron to becoming a magnet, and is well illustrated by various experiments on suspending an iron disc between the poles of a magnet; the disc has one edge weighted, and the resistance is ascertained by the time the disc takes to decrease its arc of vibration a certain quantity.

"Let the figure (fig. 3) represent a cylinder of iron between the poles of a magnet. When it is not revolving, N and S will be the induced poles; but now let it turn in the direction of the arrow, and now the induced poles, instead of being at N and S, will be carried to N′ and S′, on account of the time taken for iron to become magnetised and demagnetised. This position

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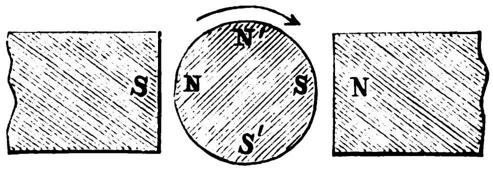
of the poles will oppose a resistance to the motion, which will become greater as the velocity is accelerated. Besides this resistance of the cylinder as a magnetic metal, there is another due to the iron as a conductor. When the cylinder is revolved, currents of electricity flow as seen in the figure (fig. 4).

FIG. 3.



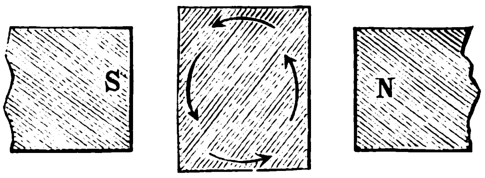


FIG. 4.

"These tend to cause the conductor to revolve around the poles in an opposite direction to that of rotation, and thus oppose a resistance. These two resistances (which form by far the greater part) are both got rid of by using the apparatus as described above."

The book from which this quotation is taken has on its title-page :—

NOTE BOOK.
FOR ADVANCEMENT IN KNOWLEDGE, &c.
No. II.
UNREVISED EDITION.
Try, Try Again.

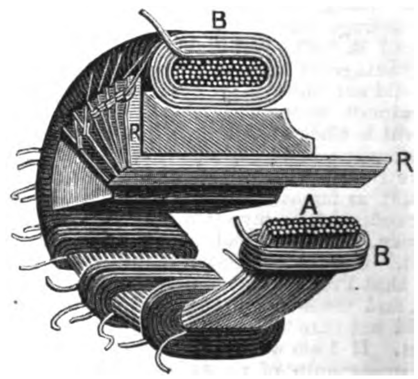
"Some, I think at this date are good, others moderate, and some bad. But I have put all into the volume because of the utility they have been to me—and none more than the bad—in pointing out to me for future, or rather, after time, the faults it became me to watch and avoid."—*Faraday.*

Mr. Hathaway says: "In the winter of 1868–9 the armature above-described was constructed with six coils. There are two windings, one for the magnet, and the other for the external circuit. Every coil makes a circuit by itself; there is only one coil in circuit at a time. This has one advantage, viz., by putting different brushes on the armature one can take off as many currents as one pleases, from the same armature. In the actual armature, the inner core (*a*) has freedom of motion, so that it may move or not as it wants to; but the coils, *b*, *b*, revolve around it. This is what Siemens first did, until he made use of discs, and so got over the difficulty."

I bring this hitherto unknown circumstance before you as a matter of historic interest; probably if the whole truth ever became known many men have obtained like results or others equally valuable, but which have never gone beyond the note-book. You can therefore set what value you please upon these recently unearthed researches of Prof. Rowland; for my part I do not see how they can be held to anticipate anything which I am now about to lay before you unless still further evidence be forthcoming.

I now pass on to a very important stage in my career; perhaps the most important of all, when viewed from a commercial standpoint, and in these days of progress everything is looked upon either favourably or not from this ground solely. Still I should be the last to grumble. Hitherto the march of science, or intellect if you prefer it, had brought me nearer and nearer to perfection electrically; but to a Frenchman, M. Gramme, is due the credit of making my worth generally known, and of sending me forth in a shape with which mechanically or electrically little fault could be found. In fact it is not too much to say that M. Gramme was the first to produce a *practical* generator of electricity yielding absolutely *continuous* currents.

Theoretically speaking, and as you can perceive for yourself from this sketch, there is not very much difference between the Gramme and Pacinotti ring armatures. Some might go so far as to say it is a distinction without a difference. This, however, would be fallacious. The latter, you remember, had teeth or projections upon its periphery or outer face, and in the spaces between were wound the coils of wire which passed through the magnetic field. The Gramme ring, for which the inventor took out a patent in the year 1870, is thus constructed :



THE GRAMME RING.

The iron portion, or core, instead of being *solid*, as in Pacinotti's machine, is formed of a continuous length of *iron wire*, A, so coiled as to form a ring of nearly an inch in thickness.

This use of thin iron wire in the place of solid metal is a distinct improvement; magnetisation and reversals of magnetism are thereby more readily accomplished, in addition to which there are other minor advantages which I need not mention here as it would involve entering too much into scientific details which I wish to avoid. The ring is perfectly smooth on both faces, and upon it are wrapped, side by side and close together, the coils of insulated copper wire, B. The ends of these are attached, in the manner already described to you when we discussed Pacinotti's invention, to the metal collecting strips, R, upon which press the brushes for taking off the current. Without further ado, therefore, we may say that the Gramme machine operates after the manner of Pacinotti's, only that in the former the self exciting principle first described by Mr. S. A. Varley is taken advantage of. Many modifications have taken place in the anatomical form of this machine, one of the latest patterns being after the fashion of this cut. A Gramme machine, of a form now obsolete, was brought to London 12 years ago, and used for several months to produce an electric light which was shown on the clock tower of your Houses of Parliament. You remember the circumstance? I expected as much. Experiments, of which I will enumerate two or three only, were made with this machine, which developed a power hitherto undreamt of. Platinum and copper wires of 15 to 30 feet in length were rendered incandescent, and a round file ½-an-inch in diameter and 4 inches long was fused in five minutes. In fact, my progenitor made it hot for them.

These old machines had no less than three armatures or rings, the current from one being employed solely to excite the field-magnets; that from the remaining two being used for external work, as, for instance, the production of an intense electric light. *En passant* I should not forget to mention that Gramme's invention was introduced into this country by the late Richard Werdermann, a devotee of electrical science, and a victim to the hardships and disappointments which so often accompany the work of a man who is in advance of the time in which he exists. M. Gramme has lived to reap the reward of his labours in a manner which does not often fall to the lot of the

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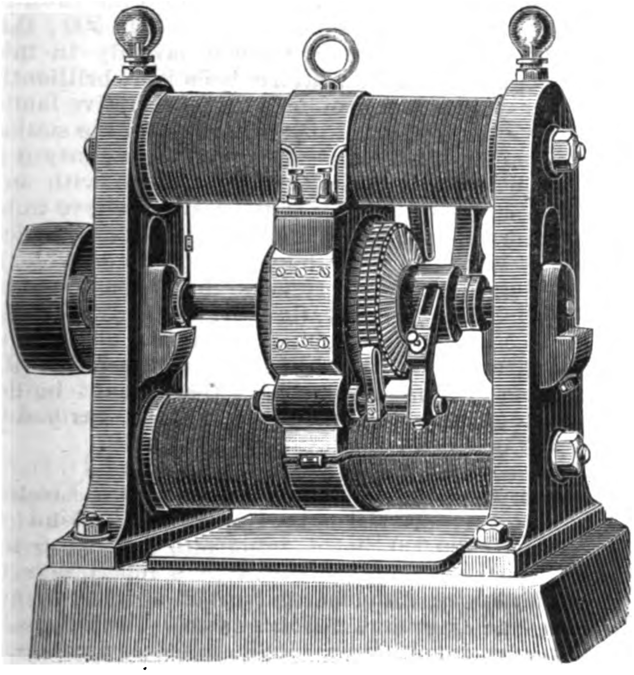
poor inventor, but he richly deserves all the honours for which he has worked so well.

He found a principle awaiting practical development, and, what Alexander Graham Bell accomplished in telephony, so did Gramme in dynamo machine construction. Opinions may differ as to the just meed of praise to be awarded to the discoverer of a new principle, and to the man who practically develops that principle; the scientist would lean towards the former, the man of business would bless the latter. As a matter of fact, both are equally deserving: without the principle the practical man has nothing on which to build, without the practician the principle might for ever lay dormant. No one, then, should begrudge the success which has attended the efforts of M. Gramme, lasting as they have done over a period of nearly 20 years.



A Modern Form of Gramme Machine.

You may, perhaps, have wondered why I have not alluded to any improvements which might have been effected in my *alternating* current brethren since the invention of Holmes? I have purposely avoided so doing for the time being, for these are but of secondary importance at present. That they have a great future is almost certain, and I shall return to them anon. But to resume.

Next in importance to the Gramme machine, and, indeed, almost contemporary therewith, stands that of Siemens.

It may not, however, be generally known that this dynamo, which has been quite as great a success as that of Gramme, was invented by von Hefner-Alteneck. This gentleman was then chief constructor to the firm of Siemens and Halske, in Berlin. I will now ask you to follow me through a short description of the development which this apparatus has undergone.

(*To be continued.*)

REVIEWS.

Patents, Designs, and Trade Marks: British and Foreign. An outline of Laws and Procedure relative to Patents, Designs, and Trade Marks. By Abel and Imray. London: 28, Southampton Buildings, Chancery Lane, W.C.

The title of this book is almost sufficient to indicate the contents. The authors of the work, who are well known as patent agents and consulting engineers, have done good service by their publication, though there are many omissions in it which greatly mar its utility. An important portion of the information which most inventors are most desirous of knowing, viz., the cost of patents, is wholly left out. We also notice that no reference is made to the fact that the forms of application can be obtained through any Post Office; indeed, the general impresssion that the book gives, is that a patent can, and should, only be taken out through an agent, to whom, of course, a fee has to be paid.

Cancer and Simple Tumours Dispersed by Electricity. By G. Edgeton, M.D. London: Henry Renshaw, 356, Strand, W.C.

This is a small book of 16 pages. The information given appears to afford one more proof that electricity, when employed in a reasonable manner, proves to be of the utmost value to suffering humanity.

Note Book and Price List with useful Formulæ. R. E. Crompton & Co., Mansion House Buildings, London, E.C.

We think it would have been advisable if the compilers of this book had indicated by the title what the work was a price list of. For the benefit of our readers we may mention that it refers to "Crompton Dynamo Machines," "Projectors," "Arc Lamps," "Incandescent Lamp Fittings," "Incandescent Lamps," and "Current and Potential Indicators." The formulæ, &c., occupy 13 pages, and are chiefly tables of sizes of electric light leads, showing also the loss of potential over the same. The few formulæ that are given are very judiciously selected. The attractiveness of the book is increased by the fact that it is bound in Russian leather!

NOTES.

Domestic Electric Lighting.—Another electric light installation has been successfully completed at The Hall, New Bushey, by Mr. Henry Rogers, engineer, of Watford. The place is a large "hydropathic establishment," a sort of big private hotel, and the installation consists of 108 incandescent lamps, there being 86 20-C.P. and 22 10-C.P. Swan-Edison, 96 volts and ·6 ampères. The dynamo is a compound-wound "Manchester" machine, of Mather and Platt's, driven by countershafting off an ordinary 8 H.P. horizontal Bradford's engine, working up to 18 H.P., which was already in position at the Hall, and is used during the day for driving laundry machinery. The dynamo and lamps were tested and supplied by Woodhouse and Rawson. The engine runs at 120 revolutions per minute, producing 1,100 on the dynamo; and though the dynamo strap (owing to architectural constraint) had to be placed in the unfavourable position of perpendicularity over the pulley, the engine (the governors of which were changed by Mr. Rogers for Parson's high-speed governor) maintains the light perfectly steadily. The mains and branch mains have been laid of a gauge to allow of an extension of the number of lights to 150, if desired. The place is eminently suited for the electric light, as the interior of the house (which was built by Mr. Marjoribanks, the well-known banker, but sold owing to financial difficulties) is richly fitted with carved staircases and panels, embossed ceilings, &c., on which the soft and brilliant beams of the incandescent lamps fall with beautiful effect. The gas fittings already in position are used as supports, silk wires being taken down the chandeliers, &c., and the lamps, which have opal shades, are attached to the brasswork by Woodhouse and Rawson holders below the gas burners, so as not to interfere with the lighting of the gas, when desired. The main corridor and hall are lit by 12 pendant lamps enclosed in "dioptric" shades like large inverted acorns, and hanging from the ceiling by silk cords.

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Temporary Electric Lighting.—An exhibition has just closed at the Town Hall of a neighbouring town, Berkhampstead, which was also successfully lit by Mr. Rogers for ten days with 33 incandescent lamps of 10 C.P., supplied by accumulators (E.P.S.) charged by a small dynamo driven by an 8 H.P. portable engine used for a threshing machine, which was lent for the occasion by a neighbouring farmer. The great hall and refreshment room were lit by the electric light, while another large hall in the building, devoted to agricultural and trade exhibits, the reading room and staircase, were supplied with gas fittings specially put up for the occasion by Messrs. Sugg, the well-known gas engineers, of Westminster. An opportunity was thus offered for a comparison of the lights, and the incandescent lamp held its own well, as, though Suggs did their part in their usual masterly style and produced a blaze of light, the soft clear ray of the electric lamp produced in the large hall a perfect illumination, without the unpleasant glare on the eyes which is usually entailed by very brilliant gas. The large hall was lined with a loan collection of handsome pictures contributed by the neighbouring gentry, and the superior effect of the electric light in showing up the colours of these was generally remarked. One or two details as to time, cost, &c., may be interesting to those who have to undertake similar installations. The consumption of coal for the ten days was a little over two tons. The engine and dynamo and accumulators were located in a neighbouring yard, the mains being carried over the housetops to the Town Hall. The installation was put up by one skilled hand and a boy in three days, including bedding of engine and dynamo, &c., and taken down, packed, and removed in one day. The light was kept on for three hours each night, taking 40—42 ampères and 42 volts. The engine driver was in attendance about seven hours each day, and, after the first day or two, no electrician was present, the engine driver being instructed as to the time to run, and the switching on and off of the dynamo, and the housekeeper shutting off the lights at the required time by another switch in the building. Though unacquainted with any electrical work, the engine driver performed these duties with every satisfaction, the moral of which is that in installations of this sort, at all events where accumulators are used, and a reasonably intelligent engineman is present, it is not necessary for a professional electrician to be detained to watch the affair after the first night.

Domestic Electric Lighting in Ireland.—Mr. Arthur S. Crawford, of Crawfordsburn, has obtained the credit of being the first to introduce the electric light into a private house in the North of Ireland. There are 100 incandescent lamps, of 20 candle-power each, distributed over a very large district, the motive power being derived from the water mill at the head of Crawfordsburn Glen, where the dynamo is placed. From the mill branch off the various cables, two passing to the workmen's cottages, about 40 yards off, as Mr. Crawford gives his labourers the advantage of this clean, brilliant, and healthy means of illumination. Two more cables pass through the west gable of the mill, and running through the bridge are carried into a little meeting-house, which is situated about 200 yards off. The third set of cables are the main ones, going direct to the house. They pass through the glen for a distance of about 300 yards, and then emerge into the open fields, where they are supported on large poles, varying from 20 to 30 feet in height. The distance between the house and mill is about three-quarters of a mile, and it is estimated that the wires and cables laid average between five and six miles in length. The entire dwelling-house is fitted most tastefully with ornamental brackets, electroliers, and pendants of polished brass surmounted by globes and shades of various artistic shapes and colours. The installation has been carried out by Mr. C. MacCarthy, of Belfast, and we understand that he has secured the large contract for illuminating the entire town of Dundald with electric light in the place of the oil lamps now in use in the streets. The political situation evidently does not seriously affect Mr. MacCarthy's business.

The Central Station Installation at Paddington.—The Paddington Electric Lighting Works were on Monday visited by some of the chief officers of the Board of Trade. The party, consisting of Major Armstrong, Mr. Meysey-Thompson, and Sir Thomas Blomefield, were received by Mr. W. Shuter, manager of the Telegraph Construction and Maintenance Company, and by Mr. J. E. H. Gordon, manager of the electric light department, and were conducted through the works and the district lighted.

Gas and Water, discussing this subject, says that the powerful lamps at the ends of the hotel at Paddington blind passengers in the street with intense violet rays; that inside the station the majority of the lights are muffled by ground glass globes, until the vaunted 3,500 C.P. is reduced to something less than 500; that floods of light are scattered about lavishly in mid and upper air whilst the platform is no more brilliantly lighted than if a series of modern regenerative lamps had been employed; and that some parts of the station are in comparative darkness, the lamp whose duty it is to illuminate the clock refusing to do so with any degree of certainty. These criticisms we believe to be fairly accurate, and, seeing that the matters of which complaint is made are for the most part remediable, it is to be hoped in the interests of the company and of electric lighting generally, that Mr. Gordon will profit by our contemporary's pointed remarks. *Gas and Water*, in fairness, admits that the lights burn with remarkable steadiness, but thinks they cannot be depended upon, as one night not long ago, the gas had to be turned on upon the arrival of a mail train.

Electric Lighting in Milan.—The Milan Electric Light Company has declared a 4 per cent. dividend on a capital of £120,000, and it anticipates making 6 for the next year. This is due greatly, the report says, to the facilities for distributing light at a distance provided by the Zipernowski-Déri system. The company kept up, at 1st January, 1885, 5,300 incandescent lamps; and at 1st January, 1886, 7,177 incandescents and 66 arcs; while at the end of March, 1886, these numbers had been increased by 846 incandescents and 13 arcs.

The Electric Light Progresses in Brooklyn.—Preparations are being made to erect 143 new electric lights, to displace 860 gas lamps, in some of the thoroughfares of the eastern and western districts of Brooklyn.

Telephonic Communication v. Signalling.—In connection with the scheme for facilitating communication with the ships at Spithead by means of the telephone (already referred to in our columns), the Admiralty proposes to erect a semaphore at Fort Gilkicker, which will be in telephonic communication with Admiralty House in Portsmouth Dockyard. The Port Admiral has accordingly directed that Her Majesty's vessels arriving at Spithead are to anchor as near Gilkicker as possible.

Electric Communication between Lightships and the Shore.—An influential meeting was held at Ramsgate last Saturday to promote electric communication between lightships and the mainland. Colonel King-Harman, M.P., was among the speakers, and promised to do all in his power to get the Government to take active steps in the matter. The following resolution was voted:—"That this meeting, being of opinion that it is desirable to promote the movement for establishing electric communication between lightships and shore, a deputation wait on the Board of Trade to impress on them the importance of the subject." The appointing of the deputation was left to the Town Council.

The Telephone at Whitehaven.—Nearly twelve months have passed since the Whitehaven and Work-

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ington Exchanges were opened for business. Beginning with 19 subscribers on the list, the number has now increased to 56, an increase of 37. The total number of messages which have passed through the Exchanges during this time reach the total of 43,757. Mr. Douglas Lodder is the district manager.

The Cable Conference.—The delegates to the Cable Conference, last Friday, signed a protocol submitting to their respective Governments the conclusions arrived at during their recent session. It is recognised that the terms of the English Act of Parliament are not at variance with the convention of 1884 as regards penal provisions. With respect, however, to civil liability for injuries to cables of other companies in repairing operations, it is agreed to recommend to the Governments a declaration which virtually adopts the principle of the English Act, without accepting the limitation to different liabilities, according as the cable lies within or beyond a depth of 100 fathoms. This solution of existing difficulties was agreed to unanimously. It is proposed that the plenipotentiaries of the Powers shall meet on December 1st next, to record what has been done in each country to carry out the legislative measures necessary in order to bring the convention of 1884 into operation on January 1st next. A fresh Act of Parliament will be required in England.

Fouling an Ocean Cable.—The schooner, *Ethel*, Capt. Merchant, arrived at Gloucester, U.S.A., on April 26th. She reported that while on the Banks, April 3rd and 4th, in longitude 65° 12″, latitude 42° 33″, she fouled the old French cable. It was two days before the schooner could be cleared away from the cable, and then the anchor had to be cut away, losing it and about 60 fathoms of cable.

Telegraph Stores Wanted.—Tenders are invited for the following articles during the six months ending 31st December, delivered carriage paid at the company's telegraph stores at York, for the North Eastern Railway Company, viz.: telegraph apparatus, and telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the Secretary at York by noon on June 8th.

Photographic Literature.—Photography has latterly been making creditable advance as an art, and its literature is become considerable. A new candidate for public favour in connection with this pleasing occupation is *The Camera*, "a monthly magazine for those who practice photography," which is likely, if its present standard of excellence is maintained, to receive extended support. Its editor is Mr. T. C. Hepworth, and Mr. Richard A. Proctor is one of its contributors.

The Monarch of the Ocean.—Mr. J. S. Moore, an American writer on political economy, has written to a New York paper upon the "cable rate war," and the *Financial News* of the 22nd inst. reproduced his letter. The writer compares Mr. Pender to Sir Joseph Porter, of H.M.S. *Pinafore* fame, and ridicules the idea that the Commercial Cable Company has been "throwing money into the sea."

A Successful Inventor.—Mr. Charles F. Brush, the distinguished inventor and electrician, has, according to the report of American contemporaries, just completed for his own occupation the finest mansion that Cleveland, a city of superb homes, can boast. It is said to be somewhat smaller, as a whole, than other well-known Cleveland houses, but to have the largest room to be found in any private dwelling in the city, and to be beyond compare in the style and richness of its decorations.

Husband's Telephones.—The article to which a correspondent, who writes about "long distance telephony," refers, may be found in the REVIEW for February 10th, 1883.

Electric Locomotion in the States.—Some months ago a very successful experiment was made by Mr. A. H. Bauer, of the Electric Storage Company, of Baltimore, on one of the Daft motor cars, for the purpose of demonstrating the practicability of secondary batteries for street car propulsion. Since then, states the *Electrical World*, Mr. Bauer has devised a novel system that can be applied to existing cars at a very small expense. An experimental car equipped with the system has been running for the past two months on an eighth of a mile track. The car used is 20 feet in length and weighs 5,400 pounds. Two beams extend from one axle to the other, and these beams carry a motor, the armature shaft being extended and having pinions on each end which mesh into counter gears; the counter shaft carries a pinion, which in turn meshes into a gear on the car axle. The motor is wound in three sections in multiple arc, and is connected with a double switch located on the platform for throwing one, two, or three of the sections in circuit with the battery as desired. To accommodate the batteries, which are placed under the seats and are entirely out of sight, the body of the car is raised three inches, so as to bring the wheels below the floor. The batteries are set on trays upon rollers, and when changes are necessary they are run out on to platforms through doors in the sides of the car, and freshly charged ones run in. The sixty cells of the battery have the same weight as the car, and the total weight of the motor, car, battery, and gearing is 5½ tons, considerably over what would be met with in actual practice. The track is one-eighth of a mile in length, beginning at the foot of a gradient of 1 in 20, 200 feet in length, on a curve of 45 feet radius. On this track the car runs continuously for six hours at a speed of six miles per hour. Calculations have been held to show that the cost of running a line of street-cars equipped with the Bauer system, should not exceed $2·21 per car per day; the average cost of horse propulsion is $4 per car per day.

The Cost of Electrical Power.—Mr. Peukert, whose excellent articles have on several occasions been translated for our columns, shows very clearly the advantages of dynamos over galvanic- or thermo-piles as a source of electrical energy. Many points of great interest may be found in his paper, and it strikes us very forcibly that the inventors of primary batteries, who claim to produce electricity for less than nothing, might peruse it with advantage to themselves.

Carbonising Lamp Filaments.—In our continuation of the evidence given in the recent incandescent lamp patent infringement case, the facts brought forth respecting Sidot's experiments are most interesting.

West London College of Electrical Engineering.—On Wednesday, May 19th, Dr. Alexander Muirhead, the great authority on ocean telegraphy, inspected the West London College of Electrical Engineering and Submarine Telegraphy, and carefully examined the artificial cable and the submarine apparatus lately introduced at that establishment. Signals were produced on the Thomson recorder similar to those received on cables varying from 900 to 2,000 knots in length. The distinguished scientist expressed his entire satisfaction, and declared that pupils who were trained to read the cable signals he had seen that day would be fit to take duty at any foreign station. Dr. Muirhead strongly advised the principal to urge his pupils to study cable-testing as well as the manipulation of the recorder, mirror, and Morse systems, and he laid particular stress upon their understanding the construction of the switches, keys, and all parts of the various instruments used on cables that often require adjustment. The artificial cable, the switches, and all the connections were made in the workshop of the College. The engineering pupils are now engaged in the construction of a second cable for the submarine department, which is to exceed in capacity the one that gave such satisfaction to Dr. Muirhead.—*Telegraphist.*

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Electric Night Signalling.—The committee which is sitting at Keyham under the presidency of Admiral Sir William Dowell, K.C.B., for the purpose of inquiring into the important subject of day and night signals, have lately witnessed experiments at Devonport with three electric semaphores of different types, which have been placed on board the *Defiance*, torpedo ship, in St. German's river. In each case the arms of the semaphore could be distinctly seen and the signals read with accuracy and ease. The object of the trial was to ascertain which of the three semaphores is best adapted for use in the service; and a report on the matter will be presented in due course.

Electrical Appliances in the Army.—Captain I. R. J. Jocelyn, instructor in the Department of the Director of Artillery Studies, has received instructions to proceed to Devonport, in order to make himself thoroughly acquainted with the various details connected with electrical appliances made use of by inspectors of warlike stores.

Schanschieff's Battery.—Last week Mr. Christopher Davies favoured us with his views on this primary battery. In our correspondence pages this week Mr. Conry relates an experience which does not agree with that of our first-mentioned contributor. Mr. Schanschieff has, however, promised to bring one of his batteries before our notice, and we shall then publish our own results.

Watches Magnetised by Chest Protectors.—Last week we, in a moment of weakness which we now deeply regret, facetiously asked a question concerning the wearing of a chest protector on the back, a position which a correspondent informed us had been adopted by an acquaintance. That same correspondent, Mr. E. Hancock, M.E., send us the following with a request for its publication:—"The editors of this paper have publicly desired to know the effects of a magnetic chest protector when worn on the back of a person. Although I have my own ideas on the action of magnetism they are, of course, only imaginary. I do not pretend to explain the action of magnetism on the human system, only that it has become a therapeutic agent of the highest order. If its action could be explained correctly it would not make the slightest difference. It is sufficient at present to know that it does act beneficially on the system when applied sufficiently strong. A chest protecter is simply one half of a lung invigorator, which is intended to act on the lungs. If we take into consideration that half of a lung invigorator, which is usually called a chest protector, will affect anything a distance of six inches or more, and that the lungs are equally near to the back as the front, it will be seen that its action on the lungs will be the same if worn on the back or chest. Therefore, if a person has a watch it will be less affected by wearing the chest protector on the back without weakening its therapeutic action on the lungs."

The Queen and the Telephone.—Her Majesty was pleased to order the connection of her temporary residence, Newsham House, with the Town Hall, the Exhibition Buildings, the abodes of Earl Granville and the Mayor of Liverpool, and with the royal stables, &c., by means of the telephone during her short stay in Liverpool. The Queen expressed the utmost satisfaction, and said she had no idea that such wonderful strides towards perfection had been made. The whole of the special telephonic arrangements were carried out by Mr. Hope-Jones, under the able direction of the telephonic company's district manager, Mr. K. H. Claxton.

Our Columns.—We are compelled to leave over several letters and articles this week, owing to pressure of other important matter.

To our Subscribers.—We shall be glad if our subscribers, when writing upon any matters in which the ELECTRICAL REVIEW is concerned, would address their communications to the proprietors, H. Alabaster, Gatehouse & Co., and not to individual members of the firm.

Railway Contracts.—Messrs. Blakey, Emmott & Co., have again secured nearly the whole of the London and North Western Railway Company's contract for electrical apparatus and cotton-covered wire. They have also obtained a fair share of the Manchester Sheffield and Lincolnshire, and Lancashire and Yorkshire Railway contracts.

The Northern District Telephone Company.—This company is actively engaged in completing the circle of communication in the county of Durham, and before these lines are in print the trunk line between Stockton and Darlington will be opened, while a very large staff of men is employed upon the trunk between Sunderland and Wingate, which will be opened early in June, and forms the last link in the chain between Newcastle, Sunderland, and the towns in the south of the county. The new multiple switch board for the Sunderland Exchange has arrived, and is being fitted up. This will prove a very valuable acquisition, as the old switch boards were hardly equal to the work required of them, and would very soon have proved totally inadequate. The amount of work done in this district during the past half year is very large, the trunk lines alone reaching a total of over 250 miles, while Exchanges have been opened in East and West Hartlepool, Stockton, Middlesbrough, Darlington, and Durham, and the number of subscribers in these towns is very satisfactory.

Company Promotion.—An action was brought last week by Mr. Edward Brewis, stock and share dealer, against Mr. Godfrey S. Pearce, stockbroker, and Mr. Otto Rochs, electrician, all of London, to recover from them £2,000, which he alleged they obtained from him by false pretences. The action arose out of proceedings connected with the promotion by the defendants of an undertaking registered as the European, Canadian, and Asiatic Cable Company, which was to have a capital of a million and a-half sterling, in 75,000 £20 shares; and the plaintiff said he advanced his money on the assurance that a list of underwritings to the amount of £660,000 given to him was correct; that it was not correct, and that in the result, although certain allotments were made, the company was not floated. The defendants denied having made any false representations, saying that the plaintiff advanced his money simply as a speculation on being told that certain parties, including Henley's Telegraph Company, were prepared, in certain events, to enter into an agreement for underwriting certain amounts, and that the advance was made on the understanding and agreement that the plaintiff was only to be repaid out of any money coming to the defendants as promotion money. The trial ended in a verdict for the plaintiff for the £2,000, with costs.

NEW COMPANIES REGISTERED.

Self-Winding and Synchronising Clock Company, Limited.—Capital, £100,000 in £1 shares. Objects:—To purchase the letters patent, No. 15,500, dated November 25th, 1885, for "improvements in clocks, and apparatus for actuating or controlling the same by electricity," and No. 7,548, dated June 20th, 1885, for "improvements in synchronisers for clocks," the inventions of Mr. Chester Henry Pond, of Brooklyn, New York. Signatories (with one share each), J. H. A. Macdonald, 38, James Street, S.W.; J. F. Sandeman, 31, Chesham Street, S.W.; W. Clarke, C.E., 45, Parliament Street; D. Boyd, Lynn, Cheshire; W. Leatham Bright, 118, Leadenhall Street; J. A. Lund, 49, Cornhill; C. G. Nottage, 35, Collingham Road, S.W. The signatories are to appoint the first directors;

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qualification, 200 shares; remuneration, £500 per annum, and also 10 per cent. of amount divided amongst the shareholders in excess of 10 per cent. per annum. Registered, 19th inst., by Messrs. Linklater & Co., 7, Walbrook, E.C.

Kinta Alluvial Tin Company, Limited.—Capital: £50,100 in £1 shares. Objects: To acquire a concession of lands from the Regent of Perak, situate in the Rasôk Valley, Kinta, and two town sites in Telôk Anson, a port on the Perak River, Straits Settlement, and to carry on mining operations. Also to erect a line or lines of telegraph, and to transmit and convey messages by the company's wire and to make charges, and to receive payment therefor. Signatories (with one share each): H. O. Jeyes, 25, Westbourne Terrace; *A. Rooke Farmer, C.E., Kinta; E. Brett, 7, Birchin Lane, E.C.; A. W. Rixon, 10, Austin Friars; J. W. Hutchinson, 89, London Wall; Isaac Carr, 10, Austin Friars; and G. Sanders, 7, Portugal Street, W.C. The first directors are Messrs. Metcalfe Larkin, A. R. Turner, C. E. and R. H. Pye. Qualification for future directors: 100 shares. Registered 20th inst. by Mr. Rixon, 10, Austin Friars.

Colchester Electric Light and Power Company, Limited.—Capital: £25,000 in £10 shares. Objects: To carry on in all branches the business of an electric light and power company. Signatories: *Thomas Moy, Stanway Hall; *J. Cooke Hopwood, Lexden Road; *E. Smith, St. Mary's Lodge; *E. J. Sanders, Cambridge Road; E. T. Smith, Beverley Road; *H. Grimwade, Head Street, 20 shares each; J. Paxman, Hythe Hill, 10 shares; all of Colchester. Directing qualification: Shares of the nominal value of £200. Remuneration: £1 1s. to each director for every board meeting attended, and such additional sum as the company in general meeting may determine. Registered 24th inst. by Mr. Conrad Fitch, 29, Bedford Row.

Sussex Electric Light Company, Limited.—Capital: £20,000 in £5 shares. Objects: To enter into contracts for electric lighting and for supplying electric light and energy for power or transmission. Signatories (with one share each): John Sayer, 25, Norfolk Road; S. Prince, 48, West Street; E. J. Allen Davis, 48, West Street; W. Prince, 12, Middle Street; W. E. Ayres, 27, Stanford Avenue; Col. W. H. White, 41, Albany Villa; all of Brighton; and C. E. Beard, of Lewes. Directing qualification: Shares or stock of the nominal value of £250; the signatories appointed first directors.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway and Electric Appliances Company, Limited.—The annual return of this company, made up to the 12th inst., was registered on the 22nd inst. The nominal capital is £500,000 in £1 shares. 130,201 shares have been taken up, and upon 51,701 of these 12s. 6d. per share has been called up, the remaining 78,500 being fully paid. The calls paid amount to £110,368 17s. 6d., and unpaid to £444 5s.

Welsbach Incandescence Light Company, Limited.—The first return of this company, made up to the 18th inst., was filed on the 24th inst. The nominal capital is £30,000 in £1 shares. 27,555 shares have been taken up, and the full amount has been called. The sum of £27,055 has been received in respect of calls, and £500 is considered as paid upon 500 shares.

Primary Battery Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 20th inst. The nominal capital is £13,000 in £5 shares. The whole of the shares have been taken up and are fully paid, the paid up capital thus showing an increase of £6,700 as compared with the previous return.

CITY NOTES, REPORTS, MEETINGS, &c.

The West Coast of America Telegraph Company, Limited.

THE accounts for the year ending the 31st December, 1885, which the directors present to the shareholders show a gross revenue of £45,957 10s. 10d., against £52,011 10s. 7d., earned in the previous year. After deducting debenture interest and all other charges, there remains a net balance of profit of £12,890 12s. 2d., making together with £349 1s. 3d. brought forward from the previous year £13,239 13s. 5d., out of which the following dividends have been paid:—In June, 1885, 2s. per share, £3,000. In January, 1886, 3s. per share, £4,500, total £7,500, leaving an available balance of £5,739 13s. 5d.; of this amount the board recommend an addition of £5,000 to the reserve fund, which will then amount to £15,000, carrying forward £739 13s. 5d.

The unfortunate war between Chili and Peru, which happily is now at an end, has seriously affected the earnings of the company, and the general exhaustion caused by that protracted struggle will doubtless be felt for some time to come. However, there appear to be already some signs of improvement in the trade on the West Coast, and with the establishment of a more stable Government in Peru a gradual increase in the traffic may be expected.

The working expenses of the company show little variation from those in the previous year. Both cables and the repairing steamer are kept in perfect working order.

With great regret the directors announce the loss of the valuable services of their late Chairman, Mr. Robinson Kendal, who died very suddenly on March 13th last. The board has appointed in his place Mr. Alfred Marshall, formerly partner of the firm of Messrs. Frederick Huth, Grüning and Co., of Valparaiso and Lima, who has been for many years a resident on the West Coast.

The members of the board retiring by rotation are Mr. Henry Roberts and Mr. Alfred Marshall, both of whom, being eligible, offer themselves for re-election.

The West India and Panama Telegraph Company, Limited.

THE report of the directors presented at the 18th ordinary general meeting, held on Thursday (yesterday), states that the amount to credit of revenue is £38,008 18s. 7d., and the expenses have been £23,191 2s. 1d., leaving a balance of £14,817 16s. 6d., which, with the balance of £1,920 5s. 9d. brought from last account, makes a total of £16,738 2s. 3d. Of this sum the directors have placed £2,000 to reserve, leaving an available balance of £14,738 2s. 3d., with which it is proposed to deal as follows:—

	£	s.	d.
Payment of 6s. per share on account of arrears of dividend on the first preference shares ...	10,368	18	0
Balance to current half year's account	4,369	4	3
	£14,738	2	3

The traffic receipts for the half-year show a decrease of £2,176 8s. 11d. on those of the corresponding period of 1884. This decrease can only be attributed to the commercial depression which is affecting the West Indies, perhaps, even more severely than other parts of the world.

The company's ss. *Grappler*, referred to in the last report as being on her way home, has, after a thorough overhaul in the Thames, returned to the West Indies with 250 knots of cable on board, and the directors have great satisfaction in adding that she has since repaired the original Cuba-Jamaica section with an expenditure of 71 knots, thus duplicating a most important section of the company's system.

The duplicate Jamaica-Porto Rico cable, which it will be remembered was restored on the 24th October, 1884, again became interrupted on the 28th November last. The *Grappler* when on her way to repair the Cuba-Jamaica section was ordered to examine the locality of this interruption. The break was found to be in about 2,400 fathoms of water, and the repair will require the expenditure of a considerable length of new cable, as no workable depth was found along the course of this line in the vicinity of the interruption. The cable must, therefore, be recovered at the nearest practicable points on each side of the break, and a new length laid in between those points. As far as soundings hitherto obtained enable an opinion to be formed, some 160 knots of cable will be required to complete the connection.

The Trinidad-Demerara section has been again interrupted and as notwithstanding costly repairs it has not worked satisfactorily for some years, proposals have been made to the Colony of British Guiana for laying a new cable. The length that may be required for this renewal will be over 300 knots. If the company's proposals are accepted, the cost of this new cable, as well as that of the Cuba-Jamaica and Jamaica-Porto Rico repairs already referred to, will cause heavy drafts on the reserve fund.

Several breaks in the cables occurred during the half year under report, and have been repaired. All stations are now in telegraphic communication.

The shareholders were doubtless as much surprised as were the directors by the appearance in November last of an advertisement under the authority of the Postmaster-General announcing that

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Her Majesty's Government were prepared to recommend Parliament to grant a subsidy for the construction and working of a submarine cable from Halifax (Nova Scotia) to Jamaica, *viâ* Bermuda, and calling for tenders for the same.

The proposed line is part of a scheme that was before the Government in 1882, when, being adversely reported upon by the late Mr. Fawcett, the Postmaster-General at the time, it was rejected. Among the grounds of Mr. Fawcett's objections were the physical difficulties of the route between Bermuda and the West Indies, which passes over the greatest known depths in the world, and the evident injustice to the West India and Panama Telegraph Company which a State-subsidised competition would involve.

Mr. Fawcett's objections were apparently so fatal to the scheme, and so novel is the project of using the national resources to compete with a system the establishment of which had received the cordial encouragement of the Colonies and the approval of the Home Government, that the directors little expected to hear of it again, and they thought themselves justified in this belief by the facts that Jamaica is already connected with the nearest telegraph system by three of this company's cables, that it has been in telegraphic communication with England for the last 15 years, and that the volume of the whole West Indian telegraphic business is not sufficient to employ a single line of cable for more than about five hours a day. In these circumstances they could not imagine that Her Majesty's Treasury, which had invariably refused every application from this company for assistance in its efforts to continue the unremunerative telegraph service of the West Indian Colonies, would sanction the payment of a subsidy for an unnecessary fourth cable whose competition for the poor traffic of the region would seriously impair the power of this company to maintain the West Indian system.

The views of the directors on the proposal were communicated to the proper authorities. It is now six months since the appearance of the advertisement, and nothing has been since heard of the scheme. It is hoped, therefore, that it will be allowed to drop, and that this company will not have—to use Mr. Fawcett's words—"just cause for complaint against Her Majesty's Government if it were now to subsidise a rival company."

In accordance with the articles of association, Henry Holmes, Esq., and Henry Weaver, Esq., retire at this meeting and offer themselves for re-election.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 21st were £2,368, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1886.

6721. "Electric lamps." S. P. THOMPSON. Dated May 19.

6738. "Portable electric lamps, suitable for use in mines." J. W. SWAN. Dated May 19.

6805. "Electric arc lamps." R. H. COURTENAY. Dated May 20.

6806. "Materials suitable for use where electro-conductive material is required." T. MACE. (Communicated by Vitrite and Luminoid Company.) Dated May 20.

6839. "Electrical apparatus for indicating, &c., the speed of rotating bodies, such as shafts." W. T. GOOLDEN, A. P. TROTTER, P. CARDEW. Dated May 21.

6845. "Primary and secondary batteries." P. BAILLY. Dated November 6, 1885. (*Complete.*)

6863. "Electro-magnetic and other stringed musical instruments." R. K. BOYLE. Dated May 21.

6869. "Transforming heat into electricity and apparatus for that purpose." C. CLAMOND. Dated May 21.

6924. "Constructing and working electrical batteries." J. T. ARMSTRONG. Dated May 22.

6925. "System of electrical intercommunication between the carriages of railway trains." A. M. CLARK. (Communicated by M. M. Bair.) Dated May 22.

6957. "Galvanic batteries." M. KOTYRA. Dated May 24.

6968. "Conduits for electric cables or conductors." H. H. LAKE. (Communicated by J. F. Munsie and H. N. May.) Dated May 24. (*Complete.*)

6969. "Electric batteries." G. V. LAGARDE. Dated May 24.

7003. "Electro-magnetic transmitter." A. H. REED. (Communicated by J. T. Williams.) Dated May 25. (*Complete.*)

7004. "Generating electric currents." R. E. B. CROMPTON. Dated May 25.

7028. "Primary electric batteries." G. F. ROSE. Dated May 25.

7031. "Electric signalling apparatus, chiefly designed for use with telephones." H. H. LAKE. (Communicated by the International Dudley Signal Company.) Dated May 25. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

4671. "Improvements in the manufacture of elements for voltaic batteries." D. G. FITZ GERALD. Dated April 15. 8d. Has for its object, first, the production of dense and coherent masses (moulded to any desired form) mainly composed of oxide of lead, and which masses are either to be reduced to porous metallic lead or converted into conductive peroxide of lead, for use as elements in voltaic batteries; secondly, to produce by chemical action a superficial coating of peroxide upon the whole or any portion of the masses to be converted into negative elements, whereby the masses can in some cases be used at once without further preparation by charging or whereby the operation of conversion into peroxide of lead by electrolysis is greatly facilitated. In carrying out this part of his invention, the inventor takes an oxide of lead, preferably the monoxide (litharge), for the production both of the positive and the negative elements of the battery. With this material he forms a plastic mass by mixing it with a solution that will effect a more or less gradual chemical change in the litharge and so cause it to "set" and to assume a dense and coherent condition. The solutions he prefers to use for this purpose are those of ammonic chloride, sulphate, carbonate, chromate, or phosphate; sodic or potassic chloride, sulphate or chromate or of an alkaline silicate or hypochlorite. With a view to further increase the hardness of the plates or elements, he prefers to add to the plastic mass a certain proportion of very finely divided lead in a moist condition. He then places a portion of the plastic mass in a mould of suitable form and applies pressure to consolidate the mass. In the manufacture of positive elements (*i.e.*, elements corresponding to the zinc in an ordinary voltaic couple) he simply maintains the plate or cylinder, produced as above described, in contact with a cathode surface in an electrolytic cell, or in contact with a plate of zinc (preferably amalgamated) immersed in a suitable electrolyte such as dilute sulphuric acid.

4720. "Improvements in wall brackets and suspensions for electric lamps." J. G. STAPELTON. Dated April 16. 8d. Consists in a removable wall bracket, which may either be rigid or swinging, and which is adapted to be supported upon and to travel along a rod or equivalent support affixed to the wall and combined with a barrel (which may be a self-coiling barrel or its equivalent) upon which is wound the necessary quantity of wire to admit of the desired removability of the bracket, the said barrel being mounted either on the bracket or on the wall in such way that the wire connection will be uncoiled when the bracket is moved away from and coiled up again when it is returned in towards the point where the wire enters or is fixed to the wall of the room.

5006. "Improvements relating to electric meters." S. F. WALKER. Dated April 22. 8d. Consists essentially of a rotating armature included in the circuit of the lamps and an electro-magnet or electro-magnets included in a shunt taken across the said circuit. The armature is geared in connection with any suitable index or counter or indicating apparatus. The resistance of the said shunt is constant, so that while the difference of potential at the points of junction with the mains is constant the current in the shunt will be constant and the intensity of the magnetic-field will be constant except as it may be affected by the counter electromotive force generated in the armature and the reactions between the said armature and magnets.

5123. "Improvements in the method of exciting the field-magnets of series-wound dynamo machines." W. H. ALLEN, R. WRIGHT, and G. KAPP. Dated April 24. 8d. Consists in joining the terminals of the series coils (in addition to the usual connection with armature and outer circit) with an auxiliary source of electricity. The source of the auxiliary current may be a primary or secondary battery, or a separate small series wound dynamo, the terminals of which are connected to the terminals of the series coils of the main dynamo.

5147. "Improvements in electric arc lamps." J. G. STATTER. Dated April 25. 8d. Relates to an improved method of disposing the magnetisable parts under the influence of the helices used to supply the motive power to electric arc lamps, and to the construction of band or flexible brakes, applied to a disc such as is referred to in a former provisional specification No. 17,008 of December 29th, 1884. In carrying out the present improvements a sheathing of iron is placed round the solenoid and provides a more complete magnetic circuit—namely, through the core to the magnetisable disc, which may, or may not be toothed, and completing its circuit by the sheathing, the air space traversed by the magnetic lines of force being thereby very much diminished. For preventing the disc from turning the inventor employs a device consisting of a flexible brake such as a cord or a thin band of metal hereinafter called "the band," which passes round the periphery of the disc. One end of this band is connected with the core of the solenoid; the band then passes round part of the periphery of the disc and is kept upon it by suitable means such as by a weight or a spring or by a weighted lever. The band adheres to the periphery of the disc by friction except for certain positions of the disc, when the pull of the weight or spring is relieved by contact with a stop, or when the tension of the spring is less by reason of eccentric attachment—or when the moment of the weighted lever is less by reason of its position—the friction of the band upon the disc is then so lessened that the tendency of the rack to turn the disc overcomes it and a feed takes place.

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7384. "Improvements in telegraphy." T. J. HANDFORD. (Communicated from abroad by T. A. Edison, of Menlo Park.) Dated June 22. 8d. The object of the invention is to increase the capacity of local telegraph lines or those lines having one or more way stations in addition to the terminal stations by the production of apparatus by means of which two sets of independent and non-interfering Morse signals can be sent back and forth over the line between terminal stations or terminal and way stations or way stations alone. In carrying out the invention there are employed for receiving instruments at each terminal and way station an ordinary non-polarised relay which acts by changes in the strength of current without regard to its polarity and a polarised relay acting by changes in the polarity of current without regard to its strength. The line is provided with a constant current from a main battery of a suitable number of cells which is decreased by the manipulation of a Morse key at each station such keys normally short circuiting a large resistance and throwing such resistance into line when depressed. The non-polarised relays which respond to this variation in current close sounder circuits at their back points. In order to reverse the polarity of the constant line current without changing its strength, there is provided at each terminal and way station, a battery, controlled by the manipulation of a key, which battery has twice the number of cells of the main battery, and which is thrown into circuit reverse to and opposing the main battery. This local battery is normally out of circuit and when thrown in neutralises the current of main battery and produces a current of opposite polarity equal to the normal current of the main battery. By these means it will be seen the line current can be reversed at any station, whether way or terminal, thus operating the polarised relay and without affecting the non-polarised relays.

7881. "Improvements in electric clocks." A. M. CLARK. (Communicated from abroad by A. Sauer, of Germany.) Dated June 29. 8d. Relates to improvements in primary and secondary clocks, the one acting to open and close circuit and thereby control the other. In place of the pressure or press contact, the inventor employs a sliding or passing contact to put and keep in motion a self acting pendulum or regulator worked by electricity. This sliding or passing contact is constructed in such a manner that the passing or sliding parts only work upon each other intermittently for a very short period, which results in the contact parts keeping clean and neither burning nor oxidising, so that the pendulum is never interrupted or hindered in its beats. The pallet escapement is also greatly simplified and is constructed without pivots or counter weights, which obviates the use of oil; thus a sticking of the escapement through gumming on of oil is obviated.

8416. "Method of constructing electrode frames for secondary voltaic batteries." A. KHOTINSKY. Dated July 11. 6d. Relates to a method of constructing frames suitable for holding the pulverulent or pasty material, such as oxides of lead, employed in secondary electric batteries.

8811. "Improvements in synchronous movements and telegraphy." P. B. DELANY. Dated July 21. 10d. Relates to improvements in the apparatus described in patent specification No. 4,787, of October 6th, 1883.

9302. "Improvements in galvanic batteries." A. R. UPWARD and W. C. PRIDHAM. Dated August 4. 8d. Relates more especially to batteries which are maintained in an active condition by the passage of gaseous chlorine through the cells. The inventors cause the gas to be delivered from the generator into the lower part of a high column or vertical pipe or pipes open at the top and also connected near the bottom by a suitable tube with the battery or batteries to be supplied. At the outlet from each battery they provide an aspirator or other form of pump in which a jet of water operates to propel the air, and they also provide an electric governor which controls the water current of the aspirator in accordance with the electric current delivered by the battery.

9564. "Improvements in electrical synchronous movements." A. L. PARCELLE. Dated August 11. 11d. Relates to apparatus for purposes similar to those of the Delany multiplex telegraph apparatus.

10540. "Improvements in electric measuring instruments." J. G. STATTER. Dated September 5. 8d. The inventor takes a coil and places within it a laminated soft iron needle of very small mass in such a position that it is not only acted upon by the deflective action of the coil, but experiences a force tending to draw it to the centre of the coil with respect to its length, after the well-known manner in which a solenoid acts upon its core; and the needle is placed in such a position with respect to its axis of rotation, that this force acts in conjunction with the hereinabove described turning force and supplements it, its movement increasing when that of the turning force is diminishing, and it is by the combination of this force with the turning force that the inventor obtains a much more even scale and a greater available range.

13011. "Improvements in electric arc lamps." W. E. HEYS. (Communicated from abroad by O. P. Loomis and H. W. Cooley, both of America.) Dated October 29. 8d. Relates more particularly to the clutch for regulating the distance between the carbons, and to an automatic cut out for throwing the lamp out of the main circuit under abnormal conditions. It also relates to the combination of certain elements which go to comprise a lamp as an entirety.

CORRESPONDENCE.

The Franklin Institute Lamp Tests.

In reply to the second letter of Messrs. Woodhouse and Rawson regarding the Duration Tests of Incandescent Lamps made by a committee of this institution, I hand you copy of a letter written by myself, which I trust that you will publish. This letter was sent and no reply received. As it has not returned through the Dead Letter Office, the inference that it was received is natural. I regret to prolong this discussion, but would like to have it known that an earnest effort was made to advise Messrs. Woodhouse & Rawson of the fact that their lamps were being tested.

Wm. D. Marks.

Philadelphia, *May 12th*, 1886.

[COPY.]

"Messrs. Woodhouse & Rawson,
"Electrical Engineers, London, England.

"Gentlemen,—Will you kindly send us such particulars regarding the manufacture of your carbons for incandescent lamps as you desire to have made public. I desire them for the forthcoming report of the Franklin Institute's Duration Tests.

"Very truly yours,
"**Wm. D. Marks.**
"*Chairman Executive Committee.*

"Philadelphia, *March 26th*, 1885."

Long Distance Telephony.

It was anticipated that when so high an authority as Mr. W. H. Preece proposed reading a paper before the Society of Telegraph Engineers on the above subject, that some practical means of accomplishing the desired purpose would be submitted. But instead of that we are treated to a *résume* of comparative statements as to the number of telephones in use in the various countries or nationalities, which, however interesting to the purchasers of Bell's original patents, is not of value from a scientific point of view.

To my mind Prof. Thompson was very much nearer the mark in saying that the way to accomplish long distance speaking was in the use of more powerful currents and less sensitive receivers, *i.e.*, such receivers as would ignore or not be affected by inductive currents that kill speech in the Bell instrument. The circuit referred to by Mr. Preece as running from the G. P. O. to the Gloucester Road Stores is certainly the worst I know of for destroying speech—in fact, I believe it is nicknamed "Kill-telephone," and it is the delight of postal officials to place it at the disposal of any sanguine inventor of a new telephone he desires to submit. In 1884 I made a receiver with the special object of ignoring those powerful disturbers, heavy inductive currents from Wheatstone wires, and got it tried upon this very wire. There was perfect silence when in circuit, and the Morse signals were read quite clear when the circuit was worked. Now had there been a transmitter equal to the Morse, I am convinced speech would have been possible, and the best form for such would have been the Hunnings. I believe were long distance working proved practicable, there would soon be a demand created for it. The late "Long Distance Telephone Company, Limited," had some £95,000 subscribed in one day; but they lacked the necessary instruments to work with.

Magneto.

[Our correspondent seems to have misunderstood the reasons why long distance telephony under certain

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conditions was found to be impossible. With underground wires or aerial wires of iron, after a certain distance the sounds become indistinguishable not because they are overpowered by external disturbances, but because they become muffled ; an increase in power of the transmitter would make these muffled sounds louder but not more distinct. The use of an aerial copper wire, on the contrary, renders the articulation perfectly clear.—EDS. ELEC. REV.]

Galvanometer Problem.

Will you permit me to call attention to an error in the solution of the galvanometer problem, page 480 ?

The tan. 30° is $\frac{1}{\sqrt{3}}$, not $\sqrt{3}$ as there stated; so that

$$R_1 : R_2 :: 3 : 1.$$

If the two galvanometers were wound with wire of the same gauge, but one containing three times as many layers as the other, the deflection of the former must be greater than that of the latter, whereas the solution given would make it less.

PI.

May 24th, 1886.

[We are obliged to our correspondent for drawing attention to the numerical error, which was made inadvertently ; the mistake does not of course affect the general solution of the problem.—EDS. ELEC. REV.]

Professor Thompson's New Telephone Receiver.

In your issue of April 30th of this year on page 405, you illustrate a telephone receiver by Professor Silvanus Thompson, which, so far as I can judge, is a form patented by Mr. José D. Husbands in 1881 or 1882, and which was referred to by you in an article upon that gentleman's telephones in 1883, in which it was pointed out that the "wriggle" produced in the upper diaphragm, by the action of the current on his armatures working within the solenoidal coil or coils (as illustrated in Pat. 4,423, 1885, *i.e.*, Professor Thompson's) gave out speech just as good and clear as in the ordinary form of telephone. It is in fact but Husband's "Electro Mechanical Telephone" with the slightest possible modification, which anyone knowing the former instrument would at once detect. As the United people considered that an infringement, I do not see that this later imitation can be clear.

"Wriggle."

Schanschieff's Battery.

Referring to the letter of Mr. G. C. Davis anent Schanschieff's battery, it may add a mite of information to the subject if I say that I have tried this battery, and find it to be not superior in E.M.F. to the old bichromate and several others, while like most single fluid batteries that I have met, it appears to have an unpleasant habit of coating the zinc plate with a bad deposit, especially if the zinc be hoisted out of the liquid and left to dry as in the bottle bichromate. It reminded me very much of the green chromate that gives such trouble with single fluid bichromates by forming on the zinc.

Added to this, the squeezing of the deposit through washleather is a troublesome and messy business, very detrimental to the skin of the hands and to the clothing.

So far from being an improvement, I do not think it is as good as one or two single fluid batteries that we have already, the liquid of which can be thrown away when exhausted ; and the prime cost is heavy. I have not reckoned up the ultimate cost, because I did not think it worth while to go into a series of experiments on the subject, as the salt formation that comes on the zinc over the amalgamation would, to my thinking, nullify the superiority of the battery if nothing else did.

Edward Conry.

23, Villiers Street, New Bushey,
May 22nd, 1886.

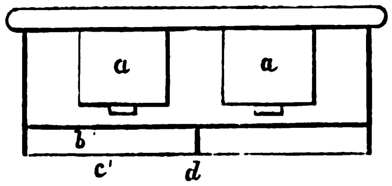
Improvements in Telephones.

In an article in your valuable paper on "Ebel's Improvements in Telephonic Apparatus," you state "that the employment of several electro-magnets to one diaphragm is a complete delusion."

Now, sir, I should like to show you that in saying so, you make a mistake.

A friend of mine, Mr. Blenheim, of New Egham, Surrey, has invented an electrical telephone, in which the employment of two electro-magnets doubles the effect.

Now, in all ordinary telephones such as Bell's, in which an iron diaphragm is used, you are quite right in saying two electro or other magnets do not double the effect. But supposing you place them thus : *a*, *a*, are two electro-magnets, *b* is a soft iron armature, *c* is a membrane of paper, and *d* is a sound post to connect the two.



Now, it is quite evident that whatever impulses are given to *b* must be communicated to the centre of the membrane, *c*. Thus no confusion of sound waves arises in the membrane.

This instrument both transmits and receives speech better and louder than any other telephone I have heard. There being no carbon in it, one can either shout or speak low into the transmitter with very little difference in the receiver.

If you think this would interest any of the readers of the ELECTRICAL REVIEW you might publish it.

W. F. S. Ashby.

Corner Hall, Staines,
May 24th, 1886.

[We should be glad to take advantage of an opportunity for trying these instruments.—EDS. ELEC. REV.]

Incandescent Lamp Making.

I hope to avail myself of Messrs. Heap and Stuart's kind offer ; if their voltmeter really possesses the qualities they claim for it, I should think no other at present in the market would be able to compete with it.

I have examined the instruments mentioned by "Ajax," but they are all unsuitable for constant practical work, and especially when used continuously as I should require. I am sorry I am unable to oblige "Ajax" by describing the process of recalibration of the Cardew's and Ayrton and Perry's voltmeters, as I always return them to the respective makers, after having first tested them by a Siemens' universal galvanometer.

With reference to incandescent lamp making, I really hope some reliable information as to the scientific processes the fibres undergo will be forthcoming, through these columns, as after the recent trial a fine field for discussion is opened. To my mind, the chief process, viz., the flashing of the carbons to bring them to a certain resistance, is kept quite secret.

Very Anxious.

May 25th, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 445.

CABLE REVENUES.

HAVE submarine telegraph cables, as dividend-earning concerns, seen their best days? It is devoutly to be hoped not; but present appearances are not very cheering from a shareholder's point of view. With scarcely an exception, diminished receipts have been the most conspicuous feature in recent directors' reports, and while in some instances the deficiency may to an extent be accounted for by local and special causes, depressed revenues are far too general to be separately dealt with and attributed to incidental and various circumstances. We have long held the opinion, and have not scrupled to express it, that the administration of many of the leading cable companies is not conducted on the wisest or most economical principle, and we feel pretty sure that one very considerable branch of the cable system will suffer to no small degree in the months that are to come, mainly as a consequence of its wrong-headedness in the past. An increasingly large proportion of the receipts which formerly went through the coffers of this section now find another medium of circulation, and, notwithstanding the determined, even desperate, attempt recently made to regain the monopoly which has been lost, are likely to continue flowing in that other channel. But the contest in the Atlantic does not answer the whole question. On lines where there is, practically speaking, no competition, such enormous quarterly decreases are recorded as ten, twenty, and up to forty thousand pounds. It can scarcely be the fact that merchants and others are tiring of the telegraph, which has been of such enormous service to them during the past decade or so. What probably more nearly accounts for the change is, that the users of the submarine system, wise in their day and generation, have devised such means for conveying the maximum amount of intelligence in the minimum number of words that, transacting an equally large, or even a greater, volume of business over the telegraph wires, they pay a much smaller sum of money for the convenience. The Chairman of the Submarine Telegraph Company has found it for some years an interesting study to trace the gradual decrease in the number of words per message sent over his lines, and while, as he has often said, this system of contraction and condensation must come to an end somewhere, the limit has apparently not yet been reached, and the only hope which shareholders of the various companies can have is, that their directors will display an amount of wisdom and business tact in coping with the difficulty for which they have decidedly not been famous hitherto.

PRIMARY BATTERIES.

A DISCUSSION has been commenced in our pages on the Schanschieff primary battery, and we hope shortly to have something definite to say on our own account respecting the inventor's claims. At the moment, however, we do not intend to make known the impression we have formed thereon, but to call attention to a matter which we fear has been too often overlooked by the sanguine inventors of primary batteries. A short time since a transatlantic contemporary published a paper by Mr. Fitch on "The Relative Working Values of Battery Materials."

To this, a correspondent, Mr. Allan V. Garratt, replied in the following terms:—"Very few men now-a-days question the relative electrical efficiency of two chemicals pound for pound, but *dollar* for *dollar*. According to Mr. Fitch's tables, it is demonstrated that a pound of chloride of silver can do 1·738 (or about 1¾) times the work of a pound of blue vitriol. Very true; but from the same data I can demonstrate that a dollar's worth of blue vitriol can do the work of one hundred and twenty-five dollars worth ($125) of chloride of silver . . . It is no exaggeration to state that in several forms of batteries very widely used at present, the labour of attending to them costs as much as, if not more than the chemicals actually consumed in the battery . . . Here comes in one of the great advantages of the use of bichromate of soda over bichromate of potash, for not only has it a higher electrical efficiency, pound for pound, and not only can you buy more of it for a dollar, but you can make several pounds of it occupy (in a battery solution) the space of one pound of bichromate of potash; and when the battery is exhausted the labour required to clean it up is much less than with bichromate of potash."

It appears to us that Mr. Garratt's remarks are borne out in the paper by Mr. Peukert which we published last week. This gentleman showed that 500 watts could be produced hourly for, say, one shilling, with the Daniell battery; but that the same amount of electrical energy from Bunsen elements would cost one shilling and sixpence per hour.

Ten of the Woodhouse-Rawson 20 candle-power lamps could be kept at their normal luminosity by the expenditure of 500 watts, so that the expense of a 20 candle-power lamp would be, if run from Daniell's cells, about 1·2 pence per hour. We know that the electromotive force of the Daniell battery is low, and that its resistance, in the form usually employed, is high; but it is very constant and cheap to manufacture. Would it not be worth while making an attempt to devise a form of this battery which could be used for electric lighting. The majority of, if not all, the primary batteries hitherto brought out supply us with electrical energy at too great a cost; for an expenditure of say three pence (the average cost per hour of most primary batteries) for a 10 candle lamp is little short of indulging in a luxury.

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HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

VII.—COMPOUND MACHINES *(continued).*

HAVING found this position and marked it, the test for determining the ampère windings may be made as above described, the results being the required exciting current for each different number of lamps to bring the machine to its desired potential. This current multiplied by the number of windings of the temporary coils gives the number of ampère windings required for supplying a constant potential to a varying number of lamps.

Having made all these adjustments and the series of measurements for determining the ampère turns for different numbers of lamps, it is advisable, though not absolutely necessary, to make the other test for determining the magnetic curve, as was described for shunt machines. It is more necessary to do this in the case of compound machines than for either shunt or series, as it enables one to see up to what limit the machine may be made to have a constant potential, and also to see whether it is practicable to attempt to make it compound at all. If there is any doubt about its being well-proportioned for a compound machine, it is best to make this test first, in order to save the trouble of the other test in case the proportions are found to be too bad for a compound machine. How to improve the proportions from the results of this test will be discussed later.

From the results of this test for the relation between the useful magnetism and the ampère windings, lay off the values of the potential on open circuit and the magnetising ampère windings as abscissæ and ordinates, respectively, and draw the curve through the points in the same way as described for shunt machines. If the machine is properly proportioned, this curve should be two tolerably straight lines connected by a short, curved line, as, *a*, *b*, in fig. 5. As the ampère windings must, from the nature of the compound winding, increase in direct proportion to the current of the machine, it is evident that the machine may be made compound only on one or the other side of the curved part, *c*, *d*, of the line, *a*, *b*; that is, for the curve represented here, the extreme number of ampère windings must be equal to or less than that for the point, *c*—that is, equal or less than *h*, *i*; or the smallest limit must be equal to or greater than that for the point, *d*—that is, *d*, *e*. It cannot possibly be made to have a constant potential for a number of ampère windings lying between *c* and *d*, except, perhaps, approximately for a very short range, if the curve is not a sharp one. As the point, *c*, designates the point at which the magnet cores are just being saturated, it will evidently be more economical to run the machine between the points, *a* and *c*, rather than between *d* and *b*, for it will then require less energy in the magnets, and, therefore, also less wire, as the amount of thick wire (series coils) will be very much less for points below *c* than for points above *d*, as is evident. If the curve is not even approximately straight at one of the two parts, it is not advisable to attempt to make the machine self-regulating with a constant potential without adjusting the brushes, except for very small ranges of the varying load. In general, the straighter this curve below the saturation point, *c*, the more nearly can the machine be made to have a constant potential.

Having made this examination and found the maximum limit to the number of ampère turns, take the results of the tests first described, for determining the ampère windings required for supplying the same potential to different numbers of lamps, and construct a curve from the values obtained, by laying off the current in the armature as abscissæ, and the required number of ampère windings as ordinates, plotting the points and drawing a line through them. This line will be somewhat like the curved line, *g*, *f*, in fig. 5, and may for the sake of direct comparison be drawn on the same sheet with the other curve, by taking the abscissæ as ampères instead of volts. The line, *c*, *k*, representing the permissible limiting value for the ampère windings, shows, by its intersection, *h*, with the curve, *g*, *f*, the extreme number of ampères, *h*, *k*, or *i*, *o*, for which the machine may be made self-regulating. The line, *g*, *n*, shows the smallest number of ampère turns which will ever be required (on open circuit), and, therefore, by its intersection with *a*, *c*, at *n* shows the limiting portion, *n*, *c*, of the curve, *a*, *c*, which is in actual use. If this part of the curve, *a*, *c* (which, under good conditions, will be very small), be straight, or nearly so, the machine may be made self-regulating, even if the rest of the curve, *a*, *b*, is very much curved. This portion, *n*, *c*, may be made quite small by making the armature resistance very small and making the number of turns on it small, as will be seen later.

It may be remarked here, that if the test had been continued for a greater number of lamps than that which is represented by the distance, *o*, *i*, the curve, *g*, *h*, would have been found to curve upward like *h*, *f*, due to the fact that the magnets are being saturated. The machine can be made self-regulating only for the tolerably straight portion of the curve, *g*, *f*. Furthermore, if *n*, *c*, is curved considerably, *g*, *h*, will also be so in about the same proportion and in the same direction.

To calculate the number of ampère windings which must be allotted to the shunt and to the series coils, draw a straight line, *g*, *h*, through the curved line, *g*, *h*, making it coincide more nearly with those portions of the curve which represent the numbers of lamps which will be used most frequently with that machine. For instance, at *g* the curve will probably deviate most from the straight line, but it is not necessary to consider that part of the curve, as the machine will probably seldom be used for such a small number of lamps.

The vertical distances to this straight line, *g*, *h*, represent the ampère windings which can be supplied by a winding consisting of series and shunt coils, and is, therefore, the nearest approach possible with such a winding to generate the ampère windings required by the curved line, *g*, *h*, obtained from the test. The more this straight line deviates from the curved one, the greater will be the deviation of the potential from the desired constant value.

From the position of this line the proportion of the series and shunt coils is calculated as follows: as to the vertical distance representing ampère turns, it is evident that these distances are made up of a constant part, *g*, *o*, and a regularly increasing part lying between the lines, *g*, *p* and *g*, *h*. It is evident, therefore, that the shunt coils, in which, as was described, the current is approximately constant for any number of lamps, must supply the ampère windings represented by *g*, *o*, and the series coils must supply the constantly increasing portion.

Up to this point it is immaterial which of the two methods of winding is to be used. In many cases it will make so little difference whether the long shunt or the ordinary method is used, that the same calculation will answer for both. Furthermore, if it is not necessary to make the machine regulate automatically as accurately as it is possible to make it, then certain corrections may be neglected, in which case also the same calculation will answer for both methods.

The conditions under which the following calculation can be used for both cases is as follows: if the machine is large; if the relative armature resistance is small; if the proportion of energy required in the magnets is not too large; if the shunt current may be comparatively small; if the brushes may be shifted slightly to adjust; if an adjustable resistance in the shunt circuit may be used within small limits; if the magnets are not over saturated; if the speed is not quite constant, thus necessitating hand regulation.

Under these conditions the following approximate method may be used: the shunt coils are calculated the same way as for an ordinary shunt machine from

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the number of ampère windings represented by the distance, *g, o,* the only difference being that the current is a smaller proportion of the whole current than in ordinary shunt machines, as will be seen. The series coils are calculated as follows: for a current in the armature, represented by *o, i,* the ampère windings must be increased by an amount represented by *h, p* ampère windings, in addition to that supplied by the shunt magnets. As this same current, *o, i,* flows through these series coils as well as in the external circuit, it is evident that the number of windings of the series coils must be this number of ampère windings represented by *h, p,* divided by the current

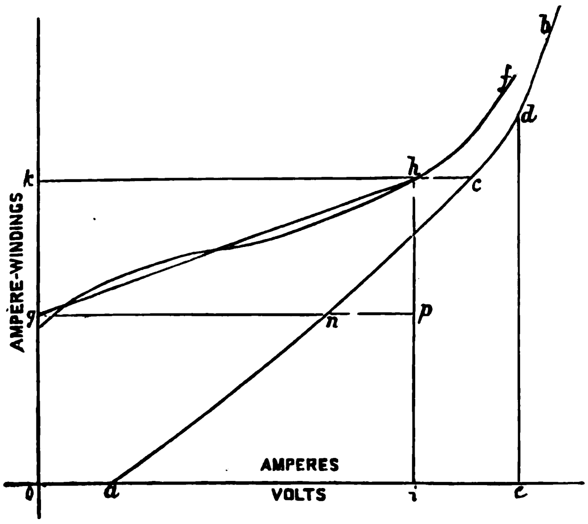


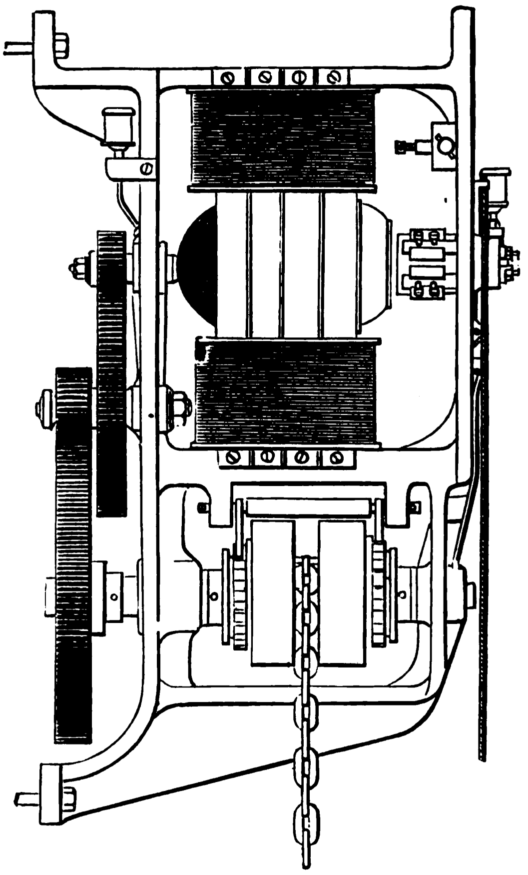
FIG. 5.

represented by *o, i.* The number of windings thus obtained will evidently be the same, no matter what the current supplied be, as it depends only on the angle, *h, g, p.* The diameter of the wire must be calculated the same way as for a series machine, from the maximum current, *o, i,* and the allowable fall of potential, which in this case must be much smaller than in a series machine. In general, the whole allowable loss of energy for the magnets can be divided into two parts, which have the proportion which the distances, *h, p,* and *p, i,* have to each other, and to the whole distance, *h, i,* giving the series coils that part, *h, p,* of the whole, *h, i,* and the shunt the rest. For instance, if *h, p* is one-third of *h, i,* then the series coils may absorb about one-third of the whole amount of energy allowed for the magnets, and the shunt coils the remaining two-thirds. If 3 per cent. of the whole energy is allowed for the magnetisation, then in this case the series coils may absorb 1 per cent. of the potential, and the shunt coils 2 per cent. of the maximum current.

As will be noticed, this method does not take into account the fact that the loss of potential in the series windings should be replaced by an increasing potential at the armature; neither does it take into account that the shunt coil current should be subtracted from that in the external circuit and series coils. Therefore, the potential of the finished machine, although approximately constant, will not be as much so as it would be possible to make it if we were to correct the proportions of the windings for the above mentioned losses. These corrections become all the more necessary, in fact sometimes quite essential, under the following conditions: if the machine is small they are essential; if the armature resistance is relatively high, that is, if the series coils supply a great part of the ampère windings, the correction for loss of potential is important, and if the magnets are over saturated this correction generally becomes essential; if the required magnetisation is relatively great, and the shunt current relatively large, the correction for this shunt current is important—in general, if the proportion of energy required by the magnets is large, both corrections become necessary; if constant speed can be maintained, and it is required to make the machine have as nearly a constant potential as it is possible to make it, then both corrections should be made.

AN ELECTRICAL HOIST.

AMONGST the advantages possessed by a dynamo-electric machine, that of its being able to be utilised for the transmission of power, says the *Mechanical Engineer*, must be considered as one of the greatest; and, as the result of manifold experiments and subsequent practical working, it has been shown that the dynamo is the most perfect and economical machine for the conversion of one form of energy into another. Amongst the various ways in which the electrical transmission of power has been applied, a very important and interesting form is that of the "electrical hoist" designed by Dr. John Hopkinson, F.R.S., and manufactured by Messrs. Siemens Bros., which we illustrate, and which partly explains itself. The electrical portion consists of an ordinary Siemens series-wound dynamo (D_2), fitted with gear for reversing the direction of the current and the lead of the brushes, and, consequently, the direction of rotation of the



machine. In the mean position, when the dynamo is at rest, both pairs of brushes are lifted from the commutator, allowing no current to pass. The dynamo runs at a high velocity, and is connected by spur gear to the lifting axle to diminish the speed of lift. On this axle a chain pulley is fitted by means of a special friction clutch, which automatically holds the weight attached to the chain, as soon as the dynamo is stopped. From the terminals on the right of the machine suitable conductors are carried to the generator. The rope on the same side is in connection with the starting and reversing gear, and when the generator dynamo is running the hoist can be used as required, and however remote from the generator.

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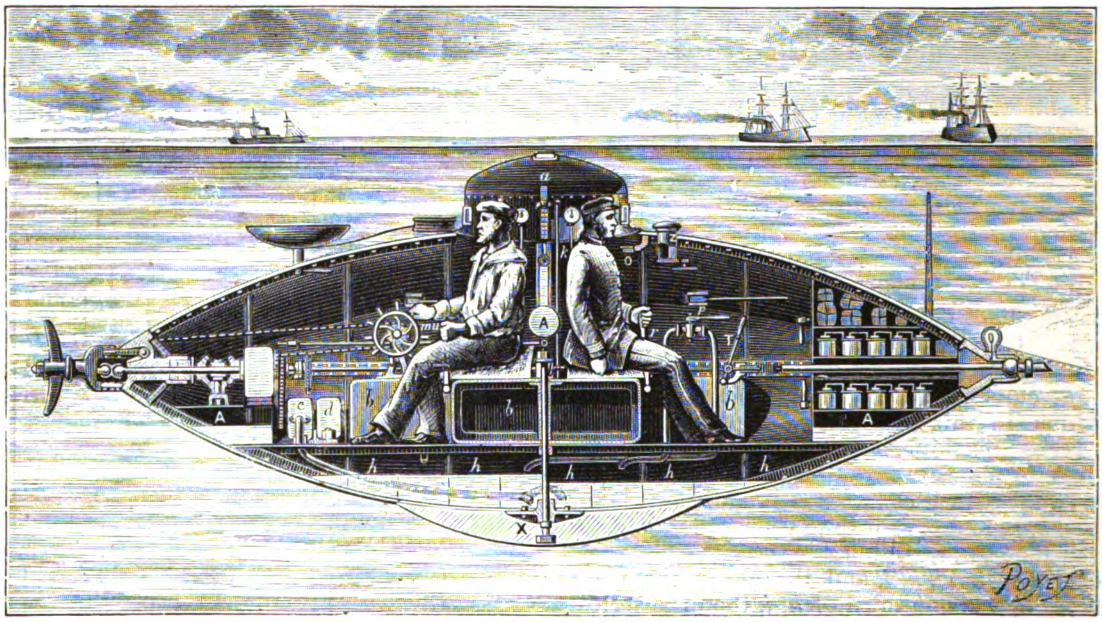
In large mills or works where the application of power is frequently required in various places, and where it is not only costly but simply impossible to transmit power by shafting, it would become necessary to provide power from separate and distinct steam or other motors ; these would in the ordinary way necessitate special attendance, and extra cost would therefore be entailed in the maintenance. In the case, however, of the electrical transmission it would be only necessary to carry conducting wires to those points where power was wanted, and fix the motor attached to gearing of the form required, in one place a hoist, in another a motor to drive a saw, a pump, or any purpose desired. In works or buildings where such a dynamo acting as generator should be fixed, it could be used at dark for lighting the place with incandescent lamps, and, again, where a dynamo has been fitted for the purpose of an electric light installation, it can be used during the daytime for the transmission of power wherever required.

The electrical hoist has been found of such great advantage and utility that it has been fixed in a good many places, and it has been proved to be capable of lifting varying loads with the greatest ease and certainty, and, the action being simple and easily understood, does not necessitate constant attention or the employment of skilled hands.



GOUBET'S SUBMARINE BOAT.

THE motive power for propelling this vessel is supplied from secondary batteries, and the electro-motor is calculated to give her a speed of 5 knots an hour. The cells number 30, 6 of which are used as a reserve. The motor is a Siemens dynamo of the type applied to tramways ; it weighs from 180 to 200 kilogrammes, and works with an E.M.F. of 48 volts and a current of 8·8 ampères. Under these conditions the boat is provided for for 10 to 12 hours. In the case of submarine explorations it might be worked during submersion by the generator of the vessel to which it would be attached, by means of the electrical transmission of power.

The torpedo is placed in the rear of the hull. The transmitting wire is coiled on a drum outside, and is connected with the commutator placed under the hand of the officer.

In the fore-part, a cutter, which is enabled by means of the lever T to project from the boat for a length of 3 metres, serves to cut the wires of the torpedoes of defence ; it is lighted by an incandescence lamp.

On arriving underneath the vessel to be attacked, which can be seen through the headlight, the officer works a pump in order to get vertically underneath, and then releases the torpedo, which ascends and attaches itself to the hull of the vessel by means of grapplers. The boat then recedes, the wire coiled round the drum unrolls and at the same time indicates the distance traversed. When this is sufficient, the officer effects the explosion. Then the boat ascends to the surface by emptying the reservoirs and regains the vessel to which it belongs.

The boat can be kept in communication with the principal vessel, either by means of a telephonic wire if it remains near, or by means of rockets.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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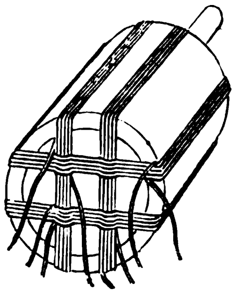
(*Continued from page* 505.)

THE original armatures of the Von Hefner Alteneck machine, more widely known as the Siemens dynamo, were, curiously enough, constructed much after the fashion of that which Professor Rowland devised and which he, in my opinion, so unaccountably kept to himself. I mean that the wires which cut through the magnetic field were not coiled tightly upon the iron ring as in the Gramme form, but were free to slide over the surface of the ring which itself remained stationary. This arrangement is now however a thing of the past, and I do not think it necessary to enter upon a more minute description thereof, so we will away to the Siemens machine proper. Its chief peculiarity lies in the manner of coiling the armature. This is generally made considerably longer than is the Gramme, and may be said to be a hollow cylinder rather than a ring as generally understood. The copper wires as you have already seen are in the Gramme ring, threaded in and out so that both outer and inner surface of the ring is covered with wire. In the Siemens armature on the contrary the outside surface only of the cylinder bears the wire. It is in fact carried lengthways along one side of the cylinder, then across the end, along the other side, across the other end, and so the operation continues until sufficient wire has been wound to form the necessary thickness of coil. This sketch will give you a very good idea of how the operation is performed, and although for the sake of clearness I show a few coils only you will understand that the cylinder is completely covered in like manner, the number of coils

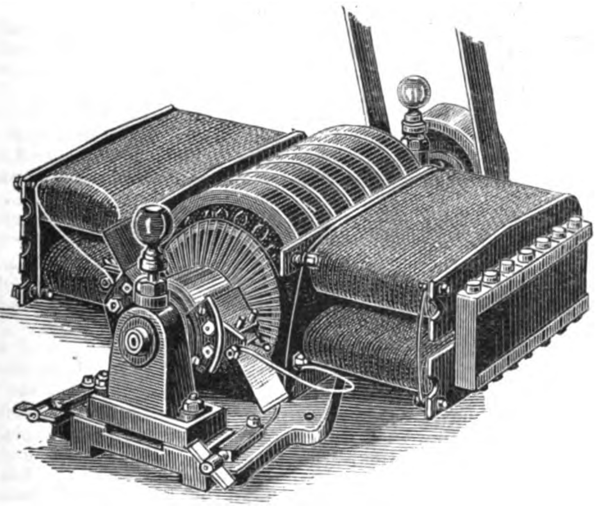
depending upon circumstances, such as the duties which the machine is called upon to perform, &c.

The free ends of the coils are fastened to the metallic slabs of the collector in the manner of Gramme. The field magnets differ somewhat from those usually found in other dynamos, but this is a matter of detail which does not affect the general reader. From the time of which I am now speaking to the present day, the Gramme and Siemens machines have run a neck



METHOD OF WINDING COILS ON SIEMENS ARMATURE.

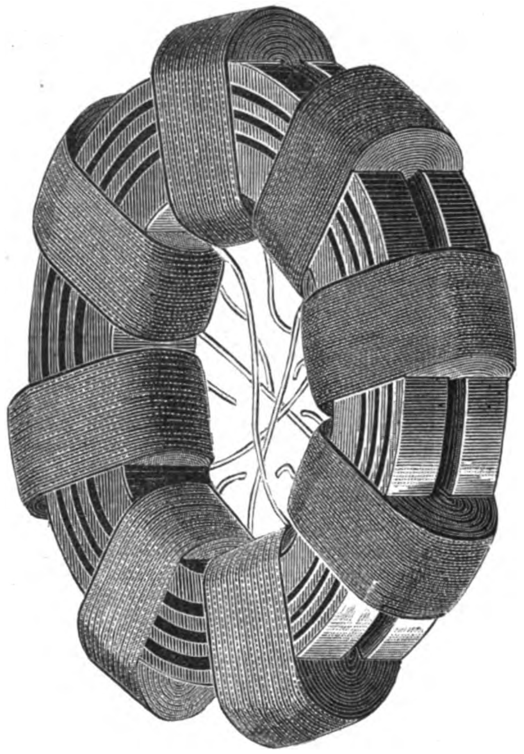
and neck race in public estimation, and although as you know fashions may differ and the guise in which one appears to-day may be very materially altered a short time hence, yet the majority of the machines by which you are here surrounded, and which to the untrained eye present such differing features are, with a few honourable exceptions, built strictly upon the lines traced out by Gramme and Siemens. I look upon these two machines as the pioneers of dynamo machine construction; they have been the means of showing the way to the further development of the dynamo in other hands as the most economical converter of one form of energy into another, and they still hold their own as typical examples of my evolution. The various steps which led to their formation having been explained it becomes a matter of comparative ease to



A SIEMENS DYNAMO MACHINE.

understand the thousand and one modifications which more modern inventors have brought forward with more or less success. I do not intend then to enter so fully into the construction of these latter-day machines, but there are several yet to be dealt with which deserve more than a passing notice. Having seen what has been accomplished by the able men of England, France, and Germany, I will now take you for a while into the real home of the dynamo. It is in America that I and my fellows are most highly appreciated, and the members of my family which there spring into existence are so numerous that our numbers may soon be fairly compared with those of the prolific rabbits which have so overrun your Australian colonies. Foremost amongst your trans-Atlantic cousins, a Nestor amongst dynamo constructors, stands Mr. F. C. Brush. It is proverbial that "a new brush sweeps clean," and when Mr. Brush appeared upon the scene there was no exception to this rule. His name is almost a household word, or at all events it should become so through you, and his dynamos have swept not only his own country, but ours also, from end to end. The most characteristic feature in the Brush dynamo lies in the form and construction of the ring, together with the method of coiling and connecting up. Comparing it with that of Gramme, I need only remind you that in his ring the coils are wound contiguously to one another completely covering the iron, and that their ends are connected to one another in consecutive series, so that the currents generated in the armature circulates in all the coils.

The Brush ring is based somewhat on that of Pacinotti, only the teeth or projections are formed on each side instead of around the periphery. The diametrically opposite coils are alone permanently connected together, and the current generated when the armature is in motion does not therefore traverse *all* the others, as will be afterwards pointed out. As in the Pacinotti ring the coils are separated by the iron projections, which are here, however, of larger sectional area.



THE BRUSH ARMATURE (OLD FORM).

The pole pieces of the field magnets are in this machine placed on *each side* of the ring, and not above and below as in the Gramme and Siemens dynamos; the Brush generator has, therefore, nothing in common with these, either in the disposition of field magnets or the position of the revolving wires cutting through the magnetic field.

The Brush ring as formerly made was of cast iron, with channelled recesses on each side, in which the copper wire coils were wound.

This sketch is a faithful representation of the armatures which were constructed till within a very short time ago, but an improvement has been made which consists in forming the ring with thin iron ribbon. In the old form there were currents set up in the *iron*, which are generally termed Foucault or "eddy" currents, and these had a deleterious effect upon the working of the machine, as indeed they also have upon any dynamo. With the new form of armature these detrimental reactions have been almost

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eliminated, and the most recent machines are now enabled to generate, with the same size of armature and running at the same speed, much more electrical energy than was formerly the case. As an instance I may tell you that where with an old machine 40 arc lamps were supplied with current, 65 lamps can now be kept alight by a new armature at the same speed.

(To be continued.)

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 501.)

Wednesday, May 12th, 1886—(*continued*).

DR. FLEMING, cross-examined by the SOLICITOR-GENERAL: Supposing a person made a carbon burner without either carbonising a fibrous vegetable substance or making a carbon wire of lampblack and tar, he would not be using such a carbon filament as Edison describes, would he?—I do not gather from the specification that it exclusively refers to those two materials alone.

He claims a carbon filament, according to your view, of any kind?—Yes.

A filament means a thread, does it not?—I think it means something more than a thread. I understand by the word filament an elongated body of small cross-section which possesses some qualities of elasticity as well as flexibility.

Can you point out to me a single passage or word in Edison's patent in which he speaks of either elasticity or flexibility?—I think they are implied in what he describes.

From what words?—From the use of the word filament.

The primary distinction between a filament and a pencil would be the comparative sectional area?—I think so.

MR. JUSTICE BUTT: I think you say, "I think the word filament involves flexibility and elasticity?"—Yes.

The SOLICITOR-GENERAL: I suppose you would agree that a thread may be made of all degrees of elasticity?—Certainly.

You may have a non-elastic thread, may you not?—I do not recollect ever having seen one.

What do you say of netting?—I think that is elastic to some extent.

Supposing one of the fibrous vegetable materials would be a bit of wood, a fragment of wood. That would be a fibrous vegetable material?—If it complied with these conditions.

"A fibrous vegetable material carbonised in a closed chamber;" that might be a bit of wood, might it not?—Certainly.

That would vary very much in rigidity from other fibrous materials you could suggest, would it not?—Certainly.

So that there are all degrees of rigidity and elasticity which would come under your description of a filament?—Yes.

From perfect elasticity and flexibility, or what we unscientific persons may call almost perfect, up to complete rigidity and non-elasticity?—It is impossible, I think, to draw a hard and sharp line in these matters.

Would you describe a wood splint as an elastic flexible material?—If it had sufficiently small cross-sections.

It is not a material you would select for elasticity or flexibility?—It is not, perhaps, the best example of an elastic and flexible body.

You would not select elasticity and flexibility as two qualities of a wood splint?—I should say it possessed those qualities.

But in a less degree than other materials which might be named?—In a less degree than some and more than others.

Have you looked at Pulvermacher's patent of November 23rd, 1878? I am quite aware that it relates to arc lighting. "My improvements relate to various apparatus for the production of electric light varying according to the methods employed, either lighting by the voltaic arc or by incandescence." That would apply to an incandescent lamp as well as to a voltaic arc, would it not?—Yes.

"For lighting by the voltaic arc, the principal organ or medium I employ is composed of two parts, invariably connected together, which I term 'rod spiral.' The central portion of this rod consists of a thinner rod composed of a paste or compound of finely powdered pure charcoal mixed with tar and pitch, or by compression of lampblack, and obtained by pressure through a draw plate." Would not that produce a wire very much like Edison's tar and lamp-black wire?—It would be a similar composition.

It would be practically identical? It is a mixture of lampblack and tar, is it not?—It would be nearly the same.

The baking operation to which Pulvermacher further on refers would be carbonisation, would it not?—Yes, I think so.

Do you not find there a wire composed of lampblack and tar kneaded together into a putty described as a material suitable for carbonisation?—I find a description of such a material, and that it could be carbonised.

And intended to be wound into a spiral, is it not, before carbonisation?—It is wound before carbonisation.

Does not Edison also propose to coat his tar and lampblack wire with a non-conducting non-carbonisable substance?—Yes, he does.

Supposing he did that, would he not obtain a material which would be identical with Pulvermacher's rod spiral?—It appears to me it would be nearly identical.

In another part of his patent, page 5, line 15, he says:—"The surrounding or enveloping part consists of a thinner carbon rod or thread also obtained by pressure through a draw plate. This thin rod is provided in the course of manufacture with a simple textile thread forming a kind of core and giving strength to the carbon." Would not that be precisely similar to what Edison has described on page 4, line 9:—"I sometimes roll a thread within a compound of lampblack and tar, so as to allow of greater convenience in handling the same?—Yes, I think it is.

Is it not used for the same purpose, that is, to give strength to the carbon? Is not that what Edison means when he says, "So as to allow of greater convenience in handling the same?"—Yes, I think it is.

With regard to your experiments on Swan's lamp. I think you told us the carbon conductor was $\frac{1}{32}$th of an inch in sectional area, and you described that as a rod or pencil. Where do you draw the line between a rod or pencil and a filament?—I do not think it is possible to give absolute dimensions.

Edison has not attempted to give dimensions except in regard to the lampblack and tar?—Except with regard to the lampblack and tar.

Can you tell us what the resistance of the lamp which you called high was?—In one measurement that I got it seemed to me to approach 500 ohms.

Where there is greatest resistance there would be greater heat, would there not?—There would.

And heat which would fuse the metal attachments?—If their temperature were high they would undoubtedly fuse.

I will ask you a question about Gimingham's patent. As I understand the description of his invention, it consisted of placing the carbon burner in sockets of platinum?—Carbon filaments in sockets of platinum.

They fashioned the ends of the platinum wire into the form of a socket, and his idea was that the carbon would rest in those sockets?—It was his idea.

He did not state any means for squeezing the carbon. Have you ever tried Gimingham's pure and simple to find whether that answers?—I have.

Do you not find that it gets loose?—Not in the lamps I have had made in that manner.

Without the application of any cement or pincers or anything of that kind?—Without any application of cement or anything of that kind.

Did you not find that owing to the heat of the carbon when the current passed through it it enlarges the platinum socket and the conductor becomes loose and uncertain?—Not if the socket were well made.

There is no novelty in the way in which he describes the making of the socket? It is as well known as possible that you can make a socket by flattening the end of a thing and then drawing it through a draw plate?—The mode of manufacture is no novelty.

The novelty you suggest is in the application of it to uniting carbon and platinum?—Yes.

Can you tell from the appearance of the lamp handed to you whether the platinum had been pressed by nippers or other mechanical means on to the carbon?—No, I could not gather from the appearance.

You do not know whether, without the application of such mechanical force to Gimingham's socket, it would work, the conductor would be too uneven, too variable?—I think the platinum would have to be pressed round the carbon to make a joint.

You do not find in Gimingham's patent that he has told the world that in order to make the conductor as he proposes it would be necessary to press the platinum round the carbon? His idea was simply to put it into the socket and leave it there?—He says: "I mount the carbon filaments directly in these tubes."

He does not say anything about pressing the carbon into the socket?—I think that is implied in the word "mount;" I think he depends on the grip of the carbon and the tube.

Without the application of any such mechanical means as I have suggested, of a pair of nippers, or anything that you would use for the purpose?—I think those must be used in putting it in.

Did not Swan use platinum sockets?—Some kind of sockets.

MR. MOULTON: I think I ought to refer my friend to this fact before we pass on, that the Swan lamp is not referred to as an anticipation of the Gimingham.

The SOLICITOR-GENERAL: I was not aware that that was so. I presume your lordship will allow me, if necessary, to amend the particulars in that respect.

MR. MOULTON: I should say that they never detected that that was an anticipation until they came into court.

The SOLICITOR-GENERAL: Because we did not know what Gimingham's patent was. We never supposed it was anything so absurd as putting this into a socket. (To witness:) In the papers of M. Sidot he describes a way of making what he calls sticks of carbon, does he not?—Yes.

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If anybody, following Sidot's directions, treated hemp, thread, cotton, paper and silk in the manner described, would he not obtain a carbon filament?—I think he would.

Suppose Swan had put one of Sidot's carbon filaments into his lamp, is there anything to prevent his doing so?—I know of nothing to prevent him doing it.

Would you not then have had a lamp that, according to your own description, would come within Edison's second claim?—I think it would.

Let me ask one question upon Gimingham's patent. The platinum sockets are continuous with the platinum wire, are they not?—They are.

Mr. JUSTICE BUTT: That is why, I suppose, he uses the words "formed directly." Mr. Swan's sockets were distinct ones; they were platinum, but they were attached.

Re-examined by Mr. MOULTON: Have you ever tried the experiment described in Sidot's paper?—No, I have never tried it.

It consists, as far as I understand it, of making the carbon in the presence of bisulphide of carbon?—It does.

And he describes the consequence of making it in this particular way that he gets a particularly sonorous carbon, hard and sonorous?—He does.

The SOLICITOR-GENERAL: And elastic?—Yes.

Mr. MOULTON: And it is a good conductor of electricity?—It is.

Would it, being a good conductor of electricity, be of advantage in an incandescent lamp?—Not if it was too good a conductor.

I mean "a good conductor of electricity." Does not that mean good for our purpose?—No, certainly not.

I want to connect it with the phrase that appears in some of the patents, "specific resistance." Is a good conductor one with high or low specific resistance?—A good conductor is one with low specific resistance.

The SOLICITOR-GENERAL: The carbon itself has great specific resistance. He is speaking of the difference between carbons.

Mr. MOULTON: He says it is a very good conductor. He says he has obtained analogous results with flax, hemp, cotton, paper, and silk. Beyond this paper you have no knowledge of what those results are?—No.

He speaks of pencils made with this carbon giving an electric light far more intense than the light one obtains with gas retort carbon. In your opinion, what electric light is he there referring to?—The arc light, I think.

In your opinion, has that part of the paper which refers to "becomes progressively incandescent throughout its mass without burning at any particular point like ordinary carbon, and it grows cold immediately you take it from the fire," anything to do with it when subjected to heat? Is that what he refers to?—"Pencils made from this give a more intense electric light." Is that the passage?

Yes. Then the next passage: "The conducting carbon." I suppose that is the translation?

The SOLICITOR-GENERAL: "This carbon conductor" is my translation.

Mr. MOULTON: With due respect, that is not the proper translation. The words are "*charbon conducteur.*" In one sense, "*conducteur*" is a substantive," and in the other an adjective.

Mr. JUSTICE BUTT: It seems to me that Mr. Moulton is quite right. They have turned the adjective into the substantive, and the substantive into the adjective. I do not know that it makes much difference.

Mr. MOULTON: It grows warm in the middle and becomes incandescent throughout its whole mass without setting fire at any particular point, like ordinary carbon. That refers to it when exposed to the action of fire. That is evidenced from what occurs immediately afterwards, that it gets cold when you take it away from the fire. Like a poker, it gets red hot along its length. It does not catch fire in its uniformity, but it has nothing to do with it under the action of electricity. It is a first rate conductor of heat. Therefore the heat passes along it, and it gets red hot throughout. And it is not like glass, which will melt at one point and be comparatively cold a little further off. He says it is different from other carbons by its great conductivity for heat and electricity. It is a question of interpretation. These conductors, when made incandescent by electricity, do not begin at one end as they do with ordinary heat; they begin all throughout equally. The words are: "*Dans la masse.*" It occurs progressively throughout its mass.

Mr. JUSTICE BUTT: How do you interpret the words "*Sans s'allumer sur un de ses points?*"

Mr. MOULTON: I think it means without burning, or without combustion. It gets cold immediately you take it away from the fire. He says it is exactly like, or "*a la façon de metal.*" I do not know whether I ought to ask the witness whether he agrees with that interpretation, but I believe it is the interpretation Dr. Hopkinson put upon it; and I am quite sure it is the correct interpretation. (To witness): Is that how you understand this passage?—I take it to mean what you have explained, that the carbon does not burst into flame or sparkle.

With regard to flexibility and elasticity, supposing anybody was to follow out the directions of this patent, in your opinion would the filament which he would use have sufficient flexibility and elasticity for the useful purpose you have described?—I think it would.

Turning to Pulvermacher's patent, is not the article which the patentee there proposes to manufacture an arc light composed of a central rod and a cylindrical rod wound round it?—I think it is.

Mr. JUSTICE BUTT: In Pulvermacher's patent the invention is —what?

Mr. MOULTON: It is the manufacture of carbon for an arc light, consisting of a central rod of carbon and another rod wound round it while soft, and then the whole is carbonised.—I think it is.

Mr. JUSTICE BUTT: The pencil is a rod of carbon. Then I suppose the matter which is wound round is not a carbon.

Mr. MOULTON: I ought not to have said carbon. It is something which is to be carbonised also. It seems to me to be lampblack and tar and a variety of things, mainly carbon, but some volatile elements to be driven off. If your lordship will kindly look at 2*r* you will see at the left hand side of it a thin line marked *j*. I find that *j* is what is called in the specification a thin core. (To witness): What is the size of the carbons you use for arc lighting? —They vary from 10 millimetres upwards—from 5 or 6 millimetres upwards.

Is the manufactured article here anything like a filament?—Nothing at all resembling it.

The central rod here was separated from the outside one by a non-conducting material, was it not? You will find it at line 22 of page 5 of the patent.—Yes.

"The pencil or rod should be previously coated with an insulating material." I believe that this compound electric candle was really a Jablochkoff's with one of the carbons spiralled?—I gather that it was something of that sort.

I do not know whether your lordship would like me to explain that the Jablochkoff consists of two carbons like that with china clay in between them—a non-conducting refractory material. (To witness): It is shaped in this way before it is carbonised?—It is.

And it is carbonised as one whole thing, and used in that way? —Yes.

In your opinion is there anything in it which would instruct the public to do what Edison claimed in his specification?—Absolutely nothing.

The SOLICITOR-GENERAL: If my friend chooses to ignore the point I cannot help it. My question was directed as to whether it was not the same material.

Mr. JUSTICE BUTT: I rather gather that Sir Frederick Bramwell in his evidence made a great point of this, that Mr. Edison carbonised his conductor after he had formed it, and that that was a matter not known or not in use before. But there is that much in Pulvermacher, is there not, that he carbonises after formation? Do you recollect Sir Frederick Bramwell's evidence on that point?—I do, my lord, only I understood Sir Frederick Bramwell to mean as applied to incandescent lamps.

Mr. JUSTICE BUTT: Well, that may be.

Mr. MOULTON: We do not contend, and it would be easily shown to be incorrect if we did, that in making such things as electrodes for arc lighting it was not known. The question is, the manufacture of a filament for a conductor for an incandescent lamp.

The SOLICITOR-GENERAL: I understood those gentlemen to say that there was no novelty in arc lighting. I did not pursue the subject.

Mr. JOHN IMRAY, engineer and patent agent, examined by Mr. Moulton, in reply to a question as to what he understood to be the invention claimed by Mr. Edison, in specification 4,576 of 1879, said he thought the whole thing was intended to substitute a carbon of high resistance for that which had been previously used, a carbon of high resistance in a convenient and useful form to make an incandescent lamp. Prior to this specification there was no practical carbon incandescent lamp in the market; many experiments had been made, but nothing had been practically or commercially successful. Before this date, Edison and others had made incandescent lamps by using very fine metallic wire. But this was subject to very great defects, and Edison here showed how to substitute for metallic wire a carbon wire, having the qualities of the metallic wire in the respect that it could be bent or turned back upon itself like a loop or in some such form, and by using a filament which was sufficiently flexible for the purpose before carbonising, and sufficiently stiff after carbonising, to solve that difficulty. The great advantage of having the burner in that form was this: first of all, it brought the two conducting wires very near to each other, so that they could be very easily sealed through the glass. Instead of having to carry the conductor round from one end of the globe to the other, you got both conductors at one place, with the result of what seemed to him most important of all, that from this form returning upon itself it gave freedom of contraction and expansion without straining the carbon at all. The advantage in substituting carbon burners for metal was, first of all, that you got a more highly resisting conductor, but, most of all, you got a more durable one.

Mr. MOULTON: Is there not a third and even more important advantage than both those, as to the temperature which it will stand?—Yes, no doubt, I meant to include that in the durability.

Has this patent, in your opinion, led to a commercial and practical lamp being made?—Yes; all the glow lamps that are now in use are practically of this kind.

Will you look at the four claims. Are any of those claims for things that were anticipated by any of the anticipations which are contained in the defendant's notice of objections?—No. I find taking the first claim that there is nothing that described a filament of carbon of high resistance sealed to a metallic wire.

The SOLICITOR-GENERAL: Made as described, or made in any way.

Mr. MOULTON: Now, the second claim.—There is no case of a carbon filament within a receiver, made entirely of glass, with

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the air exhausted, the leading wire passing through the receiver. Then as to the third claim, there were coiled filaments or strips of metals, but there were no coiled filaments or strips of carbon as set forth. Then as to the fourth claim, it is a particular way of securing the wires to the filaments by putting in a large body of cementing material at the junctions, and carbonising, after putting it on. I find no anticipation of that.

In you opinion, is the practical value of this invention great?—Yes, I am sure it is.

Will you look at Scott's provisional specification. Is there enough in that specification, in your opinion, to show to you whether it relates to incandescent or to arc lighting?—To arc lighting, no doubt it does. He says so, as you will see if you look at the last sentence: "The electricity passes between the parts of the edges of the two hollow carbon cylinders which approach nearest to each other, those points being actually changed by the radiation of the hollow cylinders." That is one part. Then another part is on page 2, line 37.

The SOLICITOR-GENERAL: You may take that.

Mr. MOULTON: My learned friend admits it. Is there anything in that specification which, in your opinion, anticipates what is shown and claimed in Edison's, as you understand it?—No. The thing produced is for a very different purpose from Edison's, and on a very different scale. It does not suggest in any way a fine filament of carbon.

Mr. JUSTICE BUTT: I should like to know what is the smallest carbon conductor that you know of being used in the arc light?—I think you had better not ask me that, because I am not a practical lamp maker. Dr. Fleming could answer that, probably.

The SOLICITOR-GENERAL: I am told by one of our witnesses, who professes to be acquainted with it, and who no doubt is acquainted with it, that he has known it as small as the lead of a lead pencil.

Mr. MOULTON: I do not think the evidence which Dr. Hopkinson would give would be quite like that.

Mr. JUSTICE BUTT: I will ask Dr. Hopkinson afterwards. Dr. Hopkinson may say, "I never saw one thinner than what would be twice the thickness of an ordinary lead pencil." Then the Solicitor-General may call a gentleman who says, "I have seen one of the thickness of the lead of a pencil." And they will not contradict one another. But I should like to get, some time, what the real truth about it is, and what is the smallest arc light carbon conductor. I suppose the arc light conductors are all carbon.

Mr. MOULTON: They are all carbon. Of course the conductor wastes away there. But speaking generally?—Speaking generally, they run from a quarter of an inch upwards, but there are some made for chemical experiments and otherwise which are smaller.

Mr. JUSTICE BUTT: I mean in use as lamps?—I should think the very smallest would be an eighth of an inch in diameter.

Mr. MOULTON: Have not the Jablochkoff candles as small carbons as any?—Yes; I think it is from an eight of an inch to a quarter of an inch.

Are these much larger than those used for electric incandescent conductors?—Oh yes; those are very fine indeed.

In arc lights is it an advantage to have a high resistance in the carbons?—No; you want the carbon a good conductor in that case.

The light is not produced, is it, by heat generated by resistance?—No, except the resistance of the space between one carbon and the other; not of the carbon itself.

Will you take the next specification, Harrison's. Is this a practical specification for anything?—I think not. He proposes to use gun cotton as a core.

Apart from the fundamental absurdity of using gun cotton, is there anything there which can possibly suggest a good conductor for an incandescent lamp?—No, certainly not.

He suggests also plating, by electrotyping on metal. Would the result of that be a good conductor which could be used?—No. It is all evidently intended for arc lighting.

I do not want to lead you, but in your opinion is that specification utter nonsense?—I do not think it is far short of it.

The SOLICITOR-GENERAL: That is rather strong, quite apart from the irregularity.

Mr. JUSTICE BUTT: Mr. Harrison might object to that.

Mr. MOULTON (to witness): Will you kindly turn to Sidot. Would you just tell me what in your opinion is the object of that paper?—It is an account of experiments in precipitating carbon from a gas or vapour containing carbon by applying heat and thereby producing a sort of coke something like the graphite that is formed in gas retorts.

I do not know whether you have heard of its being practically applied at all?—No. The same sort of thing occurs in gas retorts—a deposit of graphite.

It is simply to make a form of coke. Will you look at the passage beginning "*Les crayons qu'on en compose?*"—It evidently means there are crayons, crayons for the arc light, because there was no incandescent light known at this time. That is, at the time this was written.

What is the ordinary meaning of "*Les crayons qu'on en compose douent une lumiere electrique beaucoup plus intense que la lumiere que l'on obtient avec le charbon des cornues à gaz*" in 1870?—Entirely the arc light.

The phrase "electric light" was a well-known phrase at that time?—Yes, perfectly well known.

Then go to the latter part of that paragraph, "*Le charbon conducteur s'échauffe à la facon d'un metal.*" What do you understand by that?—That sort of carbon which is highly conductive of heat and becomes heated like metal when you apply heat to it, not like ordinary carbons. That is to say, the heat pervades it, it being a good conductor of heat, instead of all gathering at one point.

Do the words that follow support that meaning?—Yes, it becomes light all throughout its mass without becoming extremely hot at one point.

The SOLICITOR-GENERAL: Becomes extremely light, "*S'illuminer.*"—Not necessarily; becomes light.

Mr. MOULTON: Could the words apply to its behaviour in heating by electricity?—No, because at the end of the sentence it says that it becomes cold as soon as you take it out of the fire.

Would it be true that that is characteristic of ordinary carbon under the influence of the electric current?—No.

Do electric currents make progression from point to point?—No; they flash all over.

At the very end there is a statement that the carbon referred to there presents itself in long filaments of one centimetre long?—Yes.

That is something like the filaments of wood less than half an inch long?—Yes.

Does that point to anything, in your opinion, which would at all anticipate anything in Edison's specification?—No. It means that there is a series of beads deposited joining one another—what is called a filament of beads, or a string of beads.

Would that be a sort of filament which would be at all useful?—I do not think it would.

Would the inequalities of the string of beads be especially disadvantageous?—Yes. You might have a few bright points between bead and bead, but the beads themselves would not be bright.

You remember the lamp made by Mr. Swan prior to the date of this patent. Were you present when Dr. Hopkinson gave his evidence with regard to that?—Yes.

Do you agree with him?—Yes; it is distinctly a rod of carbon. It is as near as possible, I should say, the twenty-fifth of an inch in diameter, and about an inch long, from socket to socket.

In your opinion, would that lamp teach the public what is described and claimed in Edison's specification?—Oh, no; I should think that that lamp is not at all fitted for incandescence, because of the very large conducting power throughout.

To the best of your knowledge, did that, as a fact, lead to the manufacture of any practical lamps?—Not that I ever heard of.

Will you kindly take the specification of Mr. Swan's of 1880, No. 18, and will you tell us also what invention you find there described and claimed, as you understand?—A means of getting rid of the very last particle of air or gas from the carbon of a glowing lamp by heating it by the electric current while the pump is making a vacuum. As far as I know, Mr. Swan was the first to apply this process to a carbon incandescent lamp.

Would you kindly look at Edison's specification 2,402, of 1879, page 11. In that specification, what kind of lamp is Edison dealing with?—He is dealing mostly with lamps in which metal wires are used.

It does not deal with the carbon incandescent lamp at all?—No, not all.

So far as you understand that specification, do you see any directions in it for making or improving a carbon incandescent lamp, or any indications as to anything that would be useful for that purpose?—No. He says in one sentence that you may apply to carbon sticks the process which he describes for wires, to free them from air. But he gives no directions how to do it with carbon filaments within an exhausted receiver.

The platinum is actually fused together by the process, in the platinum lamp, is it not?—He says so.

He says carbon sticks may also be freed from air. I ask whether he there points to an operation by which carbon is raised almost to the melting point, and, as it were, fused together?—Yes. It is raised to a temperature at which it becomes pasty.

Does he in any way suggest any treatment of carbon excepting that which thus makes it homogeneous and hard by almost fusing it together?—No.

The SOLICITOR-GENERAL: We have the words before us. He says, "may be freed from air."

Mr. MOULTON: I know that, Mr. Solicitor-General, and I am asking whether he suggested any treatment of carbon excepting that by which the air is driven out and it is fused together?—His object evidently was to condense the carbon.

Is there any suggestion in this patent as to using those sticks in incandescent lamps?—No, there is not. I understand it to mean sticks used for the arc lamps.

He, I believe, applies the method that he has been describing actually to improving the material of platinum, does he not?—Yes.

In your opinion, was this application to carbon sticks in order to make an improved material, or was it at all in connection with any special use of the carbon?—I take it to have been the condensing of the carbon.

Will you kindly look at Swan's specification of 1880, No. 18. Has the operation, as described by Mr. Swan, for its object the condensation of the carbon?—No; it is entirely to get rid of the occluded gases and air.

Is the operation described in Swan's patent, either as practically used, or as described, at all an operation that renders the carbon pasty or fuses it together in that way?—No; not at all. I cannot say that I have ever seen carbon heated so far as to be pasty; I have read some accounts of it, but I have never seen it, and it is not suggested here.

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I do not know whether you are prepared to say whether a filament would stand such an operation as is described, which renders it pasty?—I doubt whether it would stand it. If it was soft, I think its own weight would bend it or break it down.

I do not know whether you know whether or not the carbon is rendered by this process, as applied to filament lamps, in any way more homogeneous?—No. It seems to give it a better, a smoother and brighter surface; that seems to be all that is done to it.

In your opinion, would Edison's prior patent of 1879, No. 2,402, teach the public how to use Mr. Swan's process in the manufacture of a carbon incandescent lamp?—No, I think not. It requires some invention to take the steps that Mr. Swan took.

As a matter of fact, is that process, as described by Mr. Swan, in universal use?—I believe it is universal.

Turning to Mr. Gimingham's patent, is that a patent which in your opinion explains sufficiently the way in which the invention of the patentee is to be carried out?—Oh yes; it is very clear.

In your opinion is that a useful invention?—Yes; it is very useful for this reason, that it gets the socket which holds the carbon in one piece to the conductor. That is a very great advantage, because every way of fastening the socket, by solder or otherwise, is liable to give way by reason of the great heat.

Do you know of any anticipation of this prior to the date of the patent?—No, Of course, I know that things have been held in sockets, but I do not know any case where it is held in the socket in the same piece as the wire.

You are speaking of electric incandescent lamps?—Yes; because in that lamp of Mr. Swan's I see the carbon is held in the socket and that socket seems to be fixed to the wire by some other thing, solder or something.

Is there any special reason why incandescent lamps should have as few and as simple junctions as possible?—Yes; the joints are the weak points. If there is a slight break of continuity at the joints of course the greatest heat will develop itself there, and that will destroy the carbon at the joints.

Bodies behave differently under heat?—Yes. There are different degrees of expansion and contraction, so that there is a continual loosening of these joints when they are made of different pieces.

Mr. JUSTICE BUTT: Suppose that you have platinum socket and wire?—There would be a difference, owing to the form. A socket would not expand or contract to the same extent as a wire would.

Cross-examined by the SOLICITOR-GENERAL: I suppose you have seen a point fitting into a socket before, have you not?—Yes.

There is no novelty in that?—No, I said so.

There is no novelty in the manufacture of the socket, the flattening of the wire and drawing it through a draw-plate?—I do not think I have ever seen it. I cannot recollect it.

Have you ever seen Gimingham's pure and simple applied practically?—I never particularly observed whether it is pure and simple. It is impossible on that small scale to see exactly what it is on mere examination.

You cannot tell me from your experience whether Gimingham's without the application of some mechanical pressure to squeeze the carbon and platinum together, has ever been used?—I think that very naturally he would squeeze it. Being an open pipe or socket, one would naturally squeeze it.

Will you tell me from your experience whether you would be able to use Gimingham's in any other way?—I should most likely have to squeeze it a little. That is exactly what I should think the specification would tell.

Do you find in the specification anything about squeezing?—No.

Then please do not put things upon me. I ask you whether you find in the specification anything about squeezing the socket?—Yes, I read this, that by the combined spring of the metallic and tubular parts the carbon is fixed firmly.

I may be very stupid, but I do not see one word there about applying mechanical force to the compression of the socket?—Not when you speak of mechanical force. The mere squeezing between the finger and thumb is sufficient.

Does he not, on the contrary, tell you that it is gripped sufficiently by the combined spring of the carbon itself and the metal tube?—Yes.

Does not that, to your mind, indicate that he did not intend that mechanical force, either pressure of the fingers or by a pair of nippers, or anything of that kind, would be necessary?—No, it indicated to me that it must have some pressure, or otherwise he could not have caught the spring.

I will ask you about Swan's specification, of 1880. The practical point of that patent is this, is it not, that in order to get rid of the occluded gases which were found remaining in the carbon, however good the vacuum was made, he passed an electric current through the burner while the air pump was still running?—Yes, in order to make the vacuum more complete.

And the heat brought out the occluded gases in the carbon, did it not?—Yes; and no doubt from the rest of the bulb.

Do you not find in the first part of Edison's specification, 2,402, an exactly similar process applied, though with more detail, to an incandescent lamp with a metallic wire burner?—Yes.

And his object is to free the occluded air and gas, and to obtain a more perfect vacuum?—Yes, that is one of his objects, but there is a second object.

Then when he comes to "carbon sticks may be also freed from air in this manner," have you any doubt whatever that he is speaking of carbon sticks used as conductors in incandescent lamps?—Yes, I doubt that, because I do not know of any incandescent lamp in which carbon sticks are used.

I am not asking you that. Have you any doubt that when he describes a mode by which the metal conductors of an incandescent lamp can be freed from air before the lamp is sealed, and then says "carbon sticks may be also freed from air in this manner," he means to treat the carbon sticks in exactly the same way as he treated the wire conductor?—No; carbon sticks used in arc lamps.

Do you find a single word in that specification about arc lights?—No; but I judge from the context. He calls them sticks, and he does not claim them.

You have told me that in the earlier part, in which he describes a process of freeing the metal conductors of air, he is speaking exclusively of an incandescent lamp; and then you told me that when he says "carbon sticks may be also freed from air in this manner," he is not speaking of an incandescent lamp?—I think not.

How can you, except in an incandescent lamp, free the carbon sticks or carbon candles from air in the manner described, that is, by running the pumps after you have passed a stream of electricity through the conductor before the sealing up process?—When he wants to free a carbon stick from occluded gases, and make the surface pasty, he puts it, or any number of them, into an air-tight case, heats them by the passage of a current of electricity through them, while he keeps the vacuum going, and then, after that, he can take them out and use them in arc lamps.

Then he does, in order to free them from air, propose to place them in a close receiver?—In any close vessel.

He says "in the same manner" in a close vessel, not entirely closed, with the pump still running, and passing a stream of electricity through the carbon stick?—Yes.

Would not that be exactly Swan's process in regard to the carbon conductor?—It is very much the same process.

Do you see any difference?—Yes. Edison carries the heat much further. He wants to make them pasty.

Except that Edison proposes to have a higher heat can you suggest that there is any difference?—No, not except that.

Would there be any object in freeing the carbon sticks from air unless they were to be used in an incandescent vacuum lamp?—Yes. You may have for certain arc lights a good conducting power and great density.

Would not exposure to the atmosphere bring back the occluded gases?—Not if you had got your surface partly fused.

Would it to a partial extent?—To a partial extent it would, no doubt.

Therefore you would not free it from air? Do you know that any human being, in or out of his senses, has ever used this process of Edison's for the purpose of preparing carbon sticks for arc lamps?—I do not know that any one has.

Suppose that you have a description of a process of these platinum conductors, or metal conductors in an incandescent lamp, Edison's process, in fact, do you suggest that there would be any difficulty in applying that process to a carbon conductor?—There would be no difficulty in applying it.

(To be continued.)

NOTES.

Electric Lighting of the Folkestone Exhibition.—The electric lighting of the Exhibition of National Art Treasures at Folkestone, opened on the 22nd ult., has been entrusted to the Electrical Power Storage Company, and is one of the most interesting features of the exhibition. The whole installation has been designed by the engineers of the company as a model of a large electric lighting station, such as would be required for the lighting of a town, and both arc and incandescent systems are represented. The arrangements made enable the different groups of arc lamps to be turned on and off at will without the remaining lamps being in any way affected, and by means of the E.P.S. accumulators, a total extinction of the incandescent lamps is rendered practically impossible. As a further safeguard, the whole plant has been sub-divided, and each of the galleries and other departments is supplied from two separate and distinct circuits. Two sets of E.P.S. batteries, in glass boxes, and of the newest type, containing 31 plates in each box, are charged in the daytime, and kept as a reserve. There are in all 36 arc lamps, each giving a light of 3,000 candles, and 1,250 incandescents of 10 candle-power. The arc lamps are fixed outside for the lighting of the gardens and entrance to the exhibition, and are also suspended from the roof in the central nave, which is very brilliantly illuminated at night. The power is supplied from two Marshall engines, each giving 80 horse-power, this being transmitted by means of counter-shafts to four Crompton dynamos, which supply all

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the current for both arc and incandescent lamps. There has, up to the present, been no public exhibition for lighting which has been so carefully worked out in all its details, and electricians will doubtless find much of the apparatus well worthy of their inspection. The whole of the electric light machinery and appliances for the generation of the current are contained in a building separate from the galleries of the exhibition, being connected only by a covered way for the convenience of visitors who may desire to inspect them. This also applies to the refreshment rooms of Messrs. Spiers and Pond, for whom a similar covered way has been provided.

The lighting of the exhibition was successfully completed before the opening day; the lights being run up to one o'clock on several nights to facilitate the hanging of the pictures. The mode of lighting selected for the different parts of the building is reported to give satisfactory results, and it is proposed to utilise the building as a permanent winter resort after the closing of the exhibition, when, doubtless, the apparatus of the Electrical Power Storage Company will be retained.

Electric Lighting of Ships.—In an article on the navigation of the Suez Canal by the electric light at night, the *Shipping and Mercantile Gazette* expresses the opinion that the electric light is an expensive luxury on board ship, and says it doubts very much whether the directors of the Peninsular and Oriental Company (whose ship, the *Carthage*, has been used in the recent experiments) would care to have their whole fleet fitted with the necessary appliances to enable them to pass through the Suez Canal at night with the aid of the electric light.

Electric Lighting in a Tobacco Manufactory.—Messrs. Mather and Platt have recently completed an installation of 700 lamps in the extensive new tobacco and cigar manufactory of Messrs. W. D. & H. O. Wills, Bristol. No gas has been laid on, except for heating purposes. Two 500-lamp Edison-Hopkinson dynamos, running at a speed of 700 revolutions per minute, have been supplied for this installation, either of which is capable of maintaining the whole number of lamps in use at one time.

Electric Light Installations in France.—Some very interesting statistics up to date of May 1st have been compiled and published in the *Bulletin International De L'Electricité* for May 31st. We cannot afford the space to recapitulate the details therein mentioned, but a summary is given in the following table:—

	Number of installations.	Number of arc lamps.	Number of incandescence lamps.
Public roads	10	108	140
Public buildings	5	...	1,487
Theatres	14	324	3,244
Ships	25	52	5,947
Special houses	28	98	1,594
Shops, Cafés	49	762	3,932
Museums	3	2	800
Workshops, factories	895	4,163	33,537
Timber yards for public works ...	8	61	10
Central stations	7	...	4,630
Photo-electric apparatus	...	300	...
	1,044	5,880	55,321

The above figures although not absolutely complete, some few houses having failed to give the information demanded, are sufficiently accurate to enable one to form a very fair estimate of the state of electric lighting in France. In addition to this we observe that there are 42 installations for the electrical transmission of power, 310 horse-power being employed, the Gramme machines used therefor numbering no less than 190.

The Electric Light at Lloyds.—The printing department at Lloyds has now been fitted with the electric light by the Electrical Power Storage Company.

Temporary Electric Lighting.—On the 26th and 29th May the Indian Room at Marlboro' House was again lit throughout by the electric light, the installation being, as before, carried out by the Electrical Power Storage Company. The company also carried out on the 26th an installation of over 100 lights of 20 candle power at Dover House, which was repeated on the 29th.

The Albert Palace.—The electric lighting for this palace is, we are informed, to be on an extensive scale. A large open air theatre is being erected in the grounds in imitation of the Cafés Chantants of Paris, and among other attractions there will be a first class ballet. The front of the proscenium is to be illuminated by a double row of incandescent lamps, while a powerful arc light is to be placed on the top of the band stand opposite and directed on to the stage. The band stand itself is to be converted into a royal box. A number of tall venetian masts are to be placed in the grounds, having an arc lamp on the top of each, while from post to post and thence to the top of the band stand thousands of coloured incandescent lamps are to be suspended in festoons, the effect of which will no doubt be very pretty. The interior of the palace itself will be lighted during the summer months with arc lamps, to which are to be added some two thousand incandescent lamps during the winter when the outdoor attractions are over. A new and capacious engine house is in course of erection, and the Jablochkoff Company which has taken the contract for the lighting, has arranged with Messrs. Hornsby & Sons to supply two powerful steam engines with all latest improvements.

The Cost of Electric Lighting in Vienna.—According to published details of the cost of electric lighting at the Arcade Buildings of the Union Building Association in Vienna, a 16 candle Edison lamp costs, on the whole, 0·518d. per hour; while a gas jet costs, on the whole (including interest, &c., and the gas being at 4s. 6d.,) 0·338d.

The Electric Lighting Bills. The Select House of Lords Committee on the Electric Lighting Act Amendment Bills are still proceeding with their enquiry, and still sitting with doors absolutely closed to all but themselves, the shorthand writers, and such witnesses as they summon.

Establishment of a Telephone Exchange at Gibraltar.—Advices from Gibraltar state that Messrs. Spagnoletti and Crookes have issued a circular informing the public that they have been granted a concession for the erection of a telephone exchange in Gibraltar, to which they invite subscriptions. For the benefit of the trading community they propose to open an office on the wharf. The system is to be the same as that employed in England, and as the subscription has been fixed at the moderate sum of £10 it is anticipated that the venture will prove a great success. Telephonic communication will certainly prove a great boon in Gibraltar.

The Telephone at Athletic Meetings.—An application of the telephone which, from its promise of great usefulness, should receive considerable development elsewhere, was witnessed at the Darlington Athletic Sports last Saturday. A Byng acoustic telephone was fitted up by Mr. E. Cox-Walker to establish communication between the competitors' dressing room and the centre of the field, and by this means a great deal of time was saved previous to each race in "telegraphing" the numbers of the competitors about to run. The authorities at Stamford Bridge might, with advantage, make a note of this.

Telephone Exhibits at the Edinburgh Exhibition.—We have received from the National Telephone Company a descriptive catalogue of the company's exhibits at the Edinburgh International Exhibition. This catalogue contains eight pages of small type and describes no less than 45 instruments.

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The Portsmouth Telephone Exchange. — The Admiralty has granted permission to the Western Counties and South Wales Telephone Company to connect the torpedo school ship in Portsmouth Harbour with the telephone exchange. It is anticipated that this will prove a great boon, as the *Vernon* is in communication with the other harbour vessels and subscribers will be able to speak through to them. The members of the Royal Naval Club will, no doubt, find this extremely convenient. Considerable progress has been made of late in connection with the exchange, and it is probable that before very long a hundred members will be on the books. There is plenty of scope for future work in the district. For instance, telephonic communication with Gosport, which is separated from Portsmouth only by the breadth of the harbour, might before long be acceptable to the inhabitants generally, and particularly to those engaged in business pursuits.

Conference of Telegraph Clerks.—The annual conference of telegraph clerks was held at Swansea on Saturday, 24 delegates from important towns being present. Several matters connected with the status and interests of the telegraphic profession were discussed, the conference lasting seven hours. The questions of payment for Sunday duty and annual holidays were brought forward, and a determination expressed resolutely to urge reform. Letters were read from a large number of M.Ps. expressing sympathy and support. A resolution was passed thanking Mr. Saunders, Lord Claud Hamilton, and other members of Parliament who had undertaken to promote the claims of the provincial telegraph clerks for Sunday pay. The Swansea staff entertained the delegates to a dinner in the evening.

Telegraph Receipts.—The receipts on the telegraph service from April 1st to May 22nd, 1886, amounted to £200,000, against £210,0C0 received from April 1st to May 23rd, 1885; from April 1st to May 29th, 1886, £265,000, against £280,000, from April 1st to May 30th, 1885.

Cable Companies' Receipts.—In an article dealing primarily with the contest between the Atlantic cables, the *Financial News* gives the following statistics to show that the traffic receipts of cable companies generally are decreasing. The Atlantic companies publish neither weekly nor monthly returns, so their receipts are not included :—

Traffic Receipts of the Undermentioned Submarine Cable Companies for the last Three Months.

	1886.	1885.	Monthly decrease.	Quarterly decrease.	Annual decrease at same rate.	Per cent. of decrease on capital.	Dividends paid, 1885.
Cuba Submarine.	£	£	£	£	£	Per	Per
Capital £160,00.						cent.	cent.
February ...	2,750	2,730	+ 20				
March	3,300	3,510	−210				
April	3,300	3,886	−586				
			——	776	3,104	2	8½
Eastern.							
Capital £3,800,000.							
February ...	48,814	61,784	12,970				
March	53,016	68,296	15,280				
April	47,611	63,085	15,474				
			——	43,724	174,896	4¾	6
Eastern Extension							
Capital £2,500,000.							
February ...	33,688	40,114	6,426				
March	37,804	46,193	8,389				
April	34,292	41,233	6,941				
			——	21,756	87,024	3½	7
Great Northern.							
Capital £1,500,000.							
February ...	18,800	20,400	1,600				
March	20,000	22,800	2,800				
April	19,800	25,200	5,400				
			——	9,800	39,200	2½	8

West African Cables.—The Silvertown Company's cable ships, the *Dacia* and the *Buccaneer*, left the Thames on May 22nd, bound for the West Coast of Africa, and carrying cable for the extension of the West African Telegraph Company's system along the coast. The first object of the expedition will be to connect Bathurst with the Cape Verde Islands. This work will be on behalf of the African Direct Telegraph Company. The ships will then proceed to lay a section for the West African Telegraph Company between Sierra Leone and Konakri, which latter place the Silvertown Company has already placed in telegraph communication with Europe. The heavy cables for the landing places at Grand Bassam, Accra, and probably Porto Novo will then be laid. The ss. *Silvertown* will sail towards the end of this month with sufficient cable to connect up the above-mentioned places, and to continue the West African Telegraph Company's system to S. Thomé, Principe, Gaboon, and S. Paulo de Loanda. The Telegraph Construction and Maintenance Company are sending out their *Britannia* and *Scotia* to continue the African direct cables from Bathurst to Sierra Leone, thus duplicating the West African Telegraph Company's cables to the latter place. These ships will then connect Sierra Leone with Accra. This section will serve as a common line for the West African Telegraph Company, and the African Direct Telegraph Company. From Accra the cables will be continued to Lagos and the mouths of the Niger. We understand that as the *Scotia* will be obliged to make two trips, the Colonial Office has granted an extension of time to the Telegraph Construction and Maintenance Company for the completion of their work. The *Dacia* left Lisbon on May 29th, after taking on board the representative of the Portuguese Government, Captain E. Vasconcellos, of the Portuguese Navy. The *Buccaneer* arrived at St. Vincent on June 1st, en route for Sao Thiago and Bathurst, at which latter place she will rendezvous with the *Dacia*.

The Incandescent Lamp Underground. — An interesting application of the electric incandescent light to mining operations recently took place at Lord Vernon's Poynton and Worth Colliery, near Stockport. The lower pump rod of the main pumping shaft of the Lady Pit, by which the pits are drained, broke, leaving the bucket in the bottom some 600 feet below, and submerged in water. To remedy the rupture, divers were employed, and their operations were carried on by the light of a Siebe diver's electric lantern worked by Thame's primary battery. The Siebe lantern is a strong appliance and weighs some 83 lbs. out of water. It consists of an iron cover permitting the conductors to pass inside to a cluster of four incandescent lamps, the light of which is reflected downwards by a white reflector in the roof. A stout glass globe encircles these, and is protected from injury by iron prongs around it. Fifteen cells of Thame's primary battery were employed, and the total light obtained was about 80 candles, a luminous sphere of some 6 feet in radius being obtained under water. Mr. Thame has designed a small hand lamp supplied by four cells of his battery within the lantern, which is now used in the ether chambers of brewers. It is of the utmost importance that this lamp should be safe and free from any liability to cause explosion of the ether. It is carried into the chamber by the operatives; and we understand that Colonel Majendie has expressed his approval of the lamp for use in gunpowder works and magazines.

The Colonial and Indian Exhibition.—One of the two Fridays for which the right of excluding the public has been reserved by the Royal Commission for the Colonial and Indian Exhibition, has been allotted to the Society of Arts for their Annual Conversazione, which will be given at the Exhibition on Friday, July 16th. Arrangements have been made for the purchase, by members of the Society only, of tickets to the *fête*, on the same system as that which was adopted last year.

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Secondary Battery Patents. — A correspondent writes :—"I should be glad if any of your readers can inform me whether there is any infringement of Sellon-Volckmar's patent for secondary batteries by the B.T.K. batteries, and whether the E.P.S. can have any claim against persons using them for electrical purposes."

How to Elude Payment.—A case relating to incandescent lamps occupied the attention of the judge in the City of London Court last week, the contesting parties being Messrs. Shippey Brothers and the Jablochkoff and General Electricity Company. Messrs. Shippey claimed to have supplied the company with a number of crystal incandescent lamps, for which they sought to recover £5 15s. 6d. The answer to the case was that the company was not incorporated at the time the lamps were supplied, and that the wrong parties had been sued. It was stated that the goods were sold to the old company, and transferred by agreement to the new company, at the liquidation of the former. The lamps were exhibited at the Inventions Exhibition, and the Jablochkoff Company was awarded a silver medal for them. The judge said some rather sharp things regarding the affair, amongst others that it appeared to him that the whole thing was a juggle between the old company and the new one, and eventually he adjourned the case for the production of the liquidator's list.

The Strange History of a Dynamo.—We take the following from the *Telegraphist*: — Those of our readers who know little or nothing of the evolution of the dynamo, from the immortal discovery of Œrsted to the latest type of machine, will do well to study "The Strange History of a Dynamo as told by itself to A. Dynamicable" now being published in our esteemed contemporary the ELECTRICAL REVIEW. The author writes in a popular and almost humorous style. He avoids technicalities and mathematics, the diagrams are unmistakable, and it is clear that the Dynamicable, whoever he may be, thoroughly understands his subject. The first article appeared in No. 438, vol. 18, April 9th, and they will be continued every week. The proprietors of the ELECTRICAL REVIEW will do well to publish "The Strange History of a Dynamo" in book form at a popular price. It would be certain to have a large sale.

A Salutary Reprimand. — At the Thames Police Court last week, Messrs. Edwin Fox, of the Magnetic Telegraph Works, Westferry Road, Millwall, were summoned for committing a breach of the regulations of the Floods Act, by omitting to have a movable tide board fixed in its place. Mr. Lushington observed that by such neglect an immense amount of damage might be caused, and the defendants would have to pay a fine of £5.

Electrical Conferences.—The next electric light convention in the States will be held on August 31st, at Detroit, and the next telephone convention, on September 7th, at St. Louis.

Silicium Bronze Wire.—The employment of this wire for telephonic purposes has proved very satisfactory ; in several cases, spans have been carried right over chimneys close to chemical factories, and have stood for four years without being affected ; whereas galvanised iron, under like conditions, has rotted away in a year. The only effect of the chemical fumes on the bronze is to cause a thin coat of oxide to form on the surface. The 1·1 millimetre wire, which is in general use, weighs 8·47 kilogrammes per kilometre, and has an average breaking strain of 84 kilogrammes per square millimetre of section. The conductivity is about 43 per cent. of pure copper.

Dynamite Accident.—A serious accident occurred recently on board the *Nettle*, in Portsmouth Harbour. Some experiments had just been concluded in testing cables by means of dynamite cartridges, and the workmen emerged from their places of shelter in order to shift the cables. At this moment a canister of dynamite, believed to have previously hung fire, suddenly exploded with a loud report, and severely injured a shipwright, named John Lewis, who was standing near. He was conveyed to Haslar Hospital.

Change of Name.—We are asked to state that the firm of Cordner, Allen & Company, Limited, has changed its title to the Stanhope Company, Limited, by which name the company will henceforth be known. Mr. W. J. Cordner has retired from the company, the present directors being Messrs. James Ashworth, T. M. Collet and John S. Sawrey.

The Recent Thunderstorm.—A correspondent, subscribing himself C. G. H., writes under date May 24th to the *Morning Post* as follows :—"A sycamore tree was struck by lightning in the severe storm yesterday morning, at 8 a.m., although it stands only 30 yards from the spire of our church, on which there is a good copper conductor. Is not this unusual ? The effect upon the tree was singular, merely to strip the loose bark from its trunk, and one limb, and scatter it about with a shower of leaves. Also an oaken fence, which is nailed to the tree, has its second upright split from top to bottom ; the fifth one on the same side has a piece of some 18 inches long and 2 broad torn completely off and thrown across the road ; no other part of the fence suffered in the least. I may add, that some years ago, 100 yards from this spot, the smallest of some Lombardy poplars was struck, the finest tree within three yards of it escaping. Also a Huntingdon elm standing on the edge of a pond close by these poplars has been struck by lightning no less than three separate times, and still survives."

Another correspondent writes under date May 25th : "With reference to the letter of 'C. G. H.' in your issue of to-day, I can give an almost parallel case to that he mentions. A few years ago a lime tree on my lawn, some 60 yards from the church spire, which is 175 feet high, and on which there is a good copper conductor, was struck by lightning. In this case the effect upon the tree was as singular as that mentioned by your correspondent—viz., merely to strip the bark from the lower part of the trunk and scatter it in innumerable fine shreds within a circumference of about 15 yards. The tree still survives, but alas, our favourite cat, which had taken refuge under a seat at the foot of the tree, was killed. P.S.—Before the conductor was fixed, the tower on our church was struck by lightning and much shaken."

Electrical Purification of Copper. — Messrs. Sir Hussey Vivian & Sons, of Swansea, about a month ago, purchased from Messrs. Mather & Platt, through the Edison and Swan Company, one of the largest dynamos hitherto constructed for electrolytic purposes. It has an output of 50 volts and 1,000 ampères, at a speed of 400 revs. The weight of the entire machine is 5¼ tons. The magnet limbs are solid forgings, each weighing 22 cwt., and are shunt wound only, each limb having 260 lbs. of copper wire. The armature is constructed of bars, 0·338 square inch area, and has a resistance as low as 0·0016 ohm. The commercial efficiency of the machine is over 93 per cent. This dynamo has given such satisfaction that Messrs. Mather & Platt have recently received an order from the same firm for a second precisely similar machine.

Goubet's Submarine Boat.—Those of our readers desirous of further information respecting this vessel can find a detailed description in *La Nature* for May 8th last.

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The Shortest Way to a Funeral.—The system of electrical intercommunication between passengers and railway officials devised by Mr. S. A. Varley, is in operation on the Hull and Barnsley Railway. We have just seen a letter from one of the guards on this line to a friend. The following extract is unique of its kind :—" I must tell you the communicator acts very well. I will just give you an instance. The other day, just as we got to Ouse Bridge someone pulls the bell ; we stopped. As soon as the train stopped a man jumped out, runs down the bank, and I thought he was going to jump in the river. You would have laughed to have seen him run and me after him. He was going to a funeral and he thought that was the nearest place to get off ; not a bad cheek, had he ?"

Cut-outs for Arc Lamps.—The Woodhouse and Rawson Electric Manufacturing Company specially designed and made a number of cut-outs for the large arc lamps at the Colonial and Indian Exhibition. They are arranged to cut out the lamps with which they are connected if anything goes wrong, and to insert a resistance in the circuit equivalent to that of the arc, retaining all the time the continuity of the circuit and not putting out the rest of the lamps in circuit. They consist of an electro-magnet of double T shape, with a "bridge" armature which carries a copper horseshoe dipping into two mercury cups. The magnet is in the lamp circuit, and holds up the armature and breaks connection between the mercury cups if everything is working satisfactorily ; but if the lamp goes out from any cause the armature drops and connects the mercury cups, thus putting in the equivalent resistance, which remains until the current passes through the lamp again. This arrangement appears to be precisely similar to that employed by the late Richard Werdermann in 1878 when using his semi-incandescent lamps in series.

Through the Telephone.—For a faithful representation of the difficulties attendant upon telephoning we would call attention to *Punch* of May 15th. We could almost imagine that the "scientific farce" in our lively contemporary had been compiled from our own sad experiences.

The Electric Light a Failure Everywhere !—At a meeting of the Monte Videan Gas Company last week, the chairman stated that a proposition had been made by the board to the Government of the Principality, and if the scheme should be carried out, as he thought there was every probability that it would, they might look forward to a bright and prosperous future. The proposition was made some time before the electric light scare in the principality. Many of them had no doubt heard of the rumours with regard to the electric light there. An individual hailing from Buenos Ayres thought it would be a very good stroke of business to palm off some second-hand electric lighting plant, which was rusting in some part of the Municipality, on the Government. Unhappily the authorities fell into the net, but they said it was simply a little experiment, and that there was no meaning in it. The board heard by the last report that the whole thing had been quashed, so that he hoped they would hear nothing more about the matter. Their manager had protested at the proper time, and the board thought that he had done a very great service, not only to the company, but also to the Municipality, in saving them from embarking in a concern that would ultimately end in a fiasco. The board, if they had liked, could have established their own electric lighting plant there, but they had not done so, as they felt that it would be throwing money away in an experiment which would be fated to fail. Article 18 of the concession gave them power to adopt, with the concurrence of the Municipality, any new process or scientific discovery of any other light-producing agent superior to gas ; therefore it would be seen that no one had a right to interfere with the power they had in the matter. The electric lighting of cities had been a failure in every part of the world.

Schanschieff's Battery.—In an editorial article in the *Exchange and Mart* for the 12th ult., we notice the following amongst many other inaccuracies respecting this battery :—" The consumption of zinc is but 1 lb. per horse-power hour." We wonder where the editor of our contemporary obtained this information ? Not from the inventor himself, we feel sure ; therefore it must have been evolved from the writer's inner consciousness.

Incandescent Lamp Patents.—A glance at our Correspondence columns will show how a practical manufacturer of incandescent lamps would have answered certain of the questions put during the late trial.

NEW COMPANY REGISTERED.

Loeb Chemical Electric Light Company, Limited.—Capital £4,000 in £1 shares. Objects : to purchase and work the letters patent which have been applied for by Leon Napoleon Loeb, for the invention of a primary battery. The provisional specifications are numbered 2,647 and 2,648. Signatories : *J. S. Burroughes, 19 Soho Square, 850 shares ; *Walter Buttery, 5, Pemberton Gardens, Holloway, 100 shares ; F. J. Burt, 72, Cornhill, 10 shares ; F. R. Miller, 72, Cornhill, 10 shares ; W. J. Crump, 10, Philpot Lane, E.C., 10 shares ; R. Plumbe, 13, Fitzroy Square, 10 shares; J. Sherbrooke, 9, Gracechurch Street, 10 shares. Directing qualification, 100 shares. The company in general meeting will appoint remuneration. Registered 26th ult. by Messrs. W. A. Crump and Son, 10, Philpot Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Loeb Chemical Electric Light Company, Limited.—An agreement, dated 20th ult., and filed on the 27th ult., made between Leon Napoleon Loeb, of Church Alley, Basinghall St., and Mark Jacobs, of 11, Clarendon Street, Warwick Square, relates to the purchase of the patent rights of the former by the company for 3,000 fully paid shares of £1 each. The vendor is not at liberty to dispose of more than 1,000 of these shares during a period of 12 months from the date of allotment, and in any one year after the expiration of such period he may not (except by will or codicil) dispose of more than 200 of such shares. Registered Office, 19, Soho Square.

Electric Portable Battery and Gas Igniting Company, Limited.—The annual return of this company, made up to the 2nd ult., was registered 28th ult. The nominal capital is £100,000 in £5 shares. 16,706 shares have been taken up, and the full amount has been called thereon, the calls paid amounting to £83,515, and unpaid to £15.

Self-Winding and Synchronising Clock Company, Limited.—The registered office of this company is at 27 and 28, Leadenhall Buildings, Leadenhall Street, E.C.

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CITY NOTES, REPORTS, MEETINGS, &c.

Consolidated Telephone Construction and Maintenance Company, Limited.

THE report of the directors of this company for the year ending March 31st, states :—Out of the balance of £5,208 18s. 4d. remaining to the credit of the revenue account to March 31st, 1885, a dividend of 2½ per cent. was paid to the shareholders in June; and £310 has been paid towards a settlement of the late directors' fees, which were in abeyance. The gross profits of the year amounted to £13,473 16s. 2d. After deducting the working expenses, £3,695 11s. 1d., together with £500 written off goodwill and patents, and £359 3s. at 10 per cent. depreciation of plant, machinery, and office furniture, there remains a balance of £8,919 2s. 1d. To this must be added £682 19s. 7d. balance from the year 1884-5, which makes a total of £9,602 1s. 8d. Out of this a dividend of 2½ per cent. was paid in November last, amounting to £4,215 18s. 9d.; and your directors now recommend that a further dividend of 2½ per cent. be paid, leaving a balance of £1,170 4s. 2d. to be carried forward to the next year's account. A compromise has been arrived at with certain of the late directors in connection with their fees. Sir Alexander Armstrong and Mr. Bigelow have voluntarily relinquished their claims, and the claims of Messrs Carnegy and Spensley have been settled for the total sum of £310. Colonel Gouraud, notwithstanding the circular sent round by him to the shareholders in July, 1884, stating that he voluntarily relinquished his fees, has commenced an action against your company for the sum of £1,426 15s., and your board have instructed the company's solicitors to defend the action. This leaves Sir Julius Vogel alone unaccounted for, but against this gentleman the company have a large claim in respect of the allotment of shares at the outset of the company's history.

London Platino-Brazilian Telegraph Company, Limited.

THE eighth ordinary general meeting of this company was held at the offices, Winchester House, Old Broad Street, on Monday, under the presidency of Mr. John Pender.

The secretary having read the notice convening the meeting,

The Chairman stated that they were suffering from the depression of trade, which was being felt severely at the present time in Uruguay; and they were also suffering through the Government of the Republic not being able to pay them. They were on perfectly good terms with the Government, and both the President and the Finance Minister had informed their manager how much they appreciated the service which had been rendered them by the company. In view of that meeting he had communicated with their manager, who had sent them a telegram in reply on May 14th, stating that a law had been sanctioned creating new bonds bearing 8 per cent. interest and 4 per cent. amortisation, that the debt of the Government to the company, $40,000, would be paid almost entirely with new stock at par, and that by the first mail he was remitting £500. He (the chairman) believed that the Government would continue to do their best to pay the company. A difference had arisen between the company and the Western and Brazilian company, as stated in the report for 1884, respecting this company's proportion of the receipts for telegrams sent since the reduction of tariff. The amount in dispute had been kept in suspense in the accounts. Another difficulty against which they had to contend had been the loss of traffic on account of the competition of the Brazilian Government land lines with the cables. Their receipts from the Western and Brazilian Company in the past year had been £8,614, as compared with £10,655 in 1884 and £12,638 compared with 1883. They, therefore, had not far to seek for the cause of the diminution in their dividend. As regarded the future, negotiations were pending. It was understood that the Chambers of Brazil had adopted a principle on which they would be prepared to make an offer to the companies interested in Brazilian telegraphs. The Western and Brazilian company was the first company to be treated with, as they had the larger interest, but no arrangement could be come to without the concurrence of this company. He concluded by moving the adoption of the report, and the declaration of a dividend of 1s. a share, making, with the interim dividend, a distribution at the rate of 1 per cent. per annum. Since the present board took office they had, he said, paid £52,600 in dividends, or an average of 2 per cent. per annum.

Mr. John Hollocombe seconded the motion, which was carried unanimously, and the retiring director and auditors were reelected.

The West India and Panama Telegraph Company, Limited.

THE eighteenth ordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, on the 27th inst., under the presidency of Mr. C. W. Earle.

The Secretary (Mr. R. T. Brown) having read the notice convening the meeting,

The Chairman said they met under the somewhat depressing influence of declining traffics. In the present year, if the traffic receipts they had two years ago—in 1883—had continued what they were then, they would have been in a position, putting the same amount to the reserve fund, to pay a dividend of 5s. a share extra this year on the preference shares. The whole difference was occasioned by the depression of trade, which was particularly felt in the West Indies. The accounts were perfectly featureless as to expenditure, and they were very much on the same lines as they invariably were. The balance of £14,817 was practically the same as it was last year, although the revenue had fallen off; and the reason of its being the same was to be accounted for by their having had to bring the ships home to fetch out new cable, while the expense of the voyage was charged to cable account. In the present condition of affairs there was nothing for them to do but to maintain the cables, so as to be able to take advantage of any improvement in trade that might come about; and in connection with that consideration it was satisfactory to be able to report that the original Cuba-Jamaica cable which had been interrupted and inoperative for seven years had been repaired with a very much smaller expenditure of cable than anticipated. The interruption of this cable was in the northern half of the section, and in very deep water, and although they could get hold of the cable, so great was the depth that it was impossible to bring it up to the surface of the water. It was not in a condition to bear its own strain in lifting it to a very great height. The ship *Grappler* came home in order to take out the cargo of cable, 250 knots, and they then had an opportunity of discussing the question with the captain who had been engaged in these repairs. They left him a good deal of latitude as to what his operations should be, but sketched out what they thought would yield the greatest success, and the course that would yield the greatest success meant the saving of the greatest amount of the old cable. He went to where he found 1,300 fathoms of water, a good depth, and picked up the cable there, slipped in new cable of 46 knots, and ran to Santiago. There then remained about 25 knots to put in at the Jamaica end, and that was a total expenditure of 71 knots, whereas it was thought at one time that they would have to relay the whole of the cable. The cable was put through, and was working very satisfactorily. The other cable that had given so much difficulty—a cable very much in similar circumstances to the one just spoken about—the original Jamaica-Porto Rico cable, failed in November last. It had been for a long time interrupted, and it gave great difficulty; but in 2,400 fathoms of water the cable failed last November—not in the new cable put in, but in the original cable that had been lying there for fifteen years. It was impossible to get hold of the cable at that depth, and if they could get hold of it they could not get it up to the surface of the water, and must go to a considerable distance on either side of it until they could grapple it with success, and then join the two lengths of cable, and put it through again. The third cable—the Trinidad-Demerara section—had been again interrupted. It had been interrupted twelve times since 1879. It lay in shallow water; but there was something in the composition of the mud on that coast, poured from the rivers Essequibo and Orinoco, that has a deleterious effect on the iron wires of the cable. That cable had been there for 15 years, and it seemed to be going the way of all flesh. They had, therefore, made some proposals to the Government of British Guiana for replacing that cable with a new one of some improved construction to protect the iron wires from the effects of the mud in which the cable lay. They had not yet received any decision from the Government there, and it would not be advisable to discuss the proposals at present. But he hoped they would be able to lay a new cable there without very great sacrifice of revenue to the Company. The concluding part of the report was, perhaps, the most important. Of all the companies he ever knew there was none whose position so constantly fulfilled the idea of being between the devil and the deep sea as the West India and Panama Company. He had given instances of the disadvantages which the deep sea on the ground where they worked caused them. The other unpleasant neighbour assumed various forms. Sometimes it was a promoter with a wild scheme to connect islands where there was no traffic. On that matter they had had some revelations lately. However, it remained with the public whether these things were subscribed for. The promoters got a profit and left the public to fish for themselves, after they had made the cable, in very deep water and with very small traffic. He thought, after their experience in that part of the world, where there was very small business, and where the water was very inimical to the conditions of telegraphic working, it was not at all encouraging to subscriptions being got from the public. But the new enemy they had was their home Government. The history of this scheme, that was made the subject of an advertisement, as stated in the report, was as follows:—In the year 1882 there was a telegraph conference at Barbadoes. Representatives from the various West India colonies met there and decided that it would be expedient for them to have a direct line of communication to Halifax, Nova Scotia. They thought by doing that they would be able to get cheaper rates for their messages to England. He did not know how they expected that, because if the enterprise were conducted on commercial principles, there was no doubt that a cable all the way along the coast of America merely carrying the West India traffic, which was very small, would not be worked at so low a tariff as the land lines of America, which were supported by the traffic of the population through which those lines pass. They thought that it would be a nice thing to have a direct line, probably at the expense of the English Government. The matter was put before the Government, and the late Mr. Fawcett reported adversely upon it, and very fairly said that the West India and Panama Company would have very just cause of

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complaint if the Government subsidised a new line. He was then Postmaster-General. The next time they heard of this was that the same scheme was advised by a Royal Commission that was sent out to investigate West Indian finances and West Indian affairs in 1884, and that Royal Commission advocated this scheme. The report of the Royal Commission came into their hands after their report was printed in 1884, and they appended a notice of what they said, and their objections to the scheme. They heard nothing more of it then, until this advertisement appeared last November. It seemed curious that the Government of the day, that was so much interested and so alarmed at the depression of trade and industry at the time, should with a light heart have advised a scheme by which about two millions of English capital were to be almost ruined, because he concluded that the Cuba Company would be very great sufferers as well as themselves if this line were established. It seemed curious that a Government which went out of its way rather in appointing a commission to inquire into that subject should at the same time have adopted a scheme that would so plainly depress a very large amount of capital, and also impair very much the power of this company to maintain the West Indian connections, which extended all down the Antilles. If their revenue was to be taken from them how was the company to keep up the connections with Demerara, Barbadoes, and other important colonies? They had laid their views and objections before the Government, and had heard nothing of the matter since. He hoped the subject might be allowed to drop. If such a scheme did come forward he hoped the public would be very careful how they subscribed to it. The water through which the cable would have to pass was deeper than any they had to deal with. It was referred to by the *Challenger* expedition as the deepest in the world. They could hardly get bottom with all their appliances for sounding. In making these remarks about this particular line, he was not saying anything about the expediency of a cable from Halifax to Bermuda, where there was no cable. Bermuda was a great naval station, and no doubt it was a praiseworthy thing for the Government to try and establish telegraphic communication with such an important spot as that. But as to Jamaica, there were three cables already there. No doubt the reason for proposing this step was the idea of having solely British connections with their naval stations and garrisons. But when we had such stations as Aden, Gibraltar, Malta, India itself, and our Australian colonies, all dependent to some extent on foreign communications, it seemed strange that they should go out of their way to deal with this matter in the manner he had referred to. It seemed rather strange to tell the English taxpayers to promote a line that would do so much damage to existing British capital. He then moved:—"That the directors' report and accounts to the 31st December, 1885, submitted to this meeting be, and the same are hereby received and adopted, and that, as recommended by the board, a dividend of 6s. a share on account of arrears of dividend on the first preference shares be, and the same is hereby declared."

Mr. Wm. Ford seconded the motion, and Mr. W. Griffith and Mr. William Abbott having spoken in support of the views expressed by the chairman in reference to the proposal of the Government, the resolution was carried unanimously.

Mr. Henry Holmes and Mr. Henry Weaver were re-elected directors, and the auditor, Mr. John George Griffiths, was also re-elected.

Mr. Abbot then proposed a vote of thanks to the chairman and directors for their services in the past half year. Mr. J. Newton seconded the motion, which was carried unanimously, the proceedings thereupon terminating.

West Coast of America Telegraph Company, Limited.

THE ninth ordinary general meeting of this company was held at the offices, 50, Old Broad Street, on Wednesday, Mr. Alfred Marshall presiding.

Mr. F. L. Robinson, the secretary, having read the notice convening the meeting,

The Chairman said the accounts showed a slight saving in the West Coast, and they hoped they might be able to maintain the expenses at a similar rate for the future. The *Retriever's* expenses were about £300 higher than in the previous year; sometimes the ship was docked at the end of the year, and sometimes at the beginning, and this would account for the variation in regard to that item. They had been very fortunate in not being called upon to make any extensive repairs; in this item alone there was a saving of £1,600, and they thought it prudent to take this into consideration in recommending the comparatively large sum for reserve. The gross earnings of the company, unfortunately, showed a falling off from previous years. This was almost entirely attributable to bad trade, a great part of which was produced by the war which had been going on between Chili and Peru, and which had impoverished the people of both those countries. They could only look for a very gradual improvement of this state of affairs. There was one item which called for explanation, the interest account. A sum of £381 was placed to credit, whereas it would seem that the investment of £10,000 of the reserve at 8 per cent. would produce a large sum. On the instructions of their auditors they had debited this account with loss of interest, incurred by cable transfers. They had up to this time adopted the plan of remitting money, instead of by bills, by cable transfers. This cost them the difference in the exchange, as the bankers charged a higher rate of exchange. They were taking measures to avoid this loss in future by resuming remittances by bills. The reports of their managers were very satisfactory as regarded the electrical condition and the thorough working order of the lines, and they were doing everything in their power to keep them in satisfactory order. Their staff, he believed, was quite exceptionally efficient. He moved in conclusion the reception and adoption of the report.

Mr. T. F. Campbell seconded the resolution.

The Chairman, replying to questions, said the receipts for the year showed no improvement. The traffic to May 31st had been £167,000 as against £208,000. During the last month, however, there seemed to have been some little sign of a reaction.

Mr. Taylor suggested that the *Retriever* was insured over her value, and said that she could be replaced for several thousands less now than was given for her in the first instance. This might cause some trouble.

The Chairman promised to consider the matter, after which the retiring directors, Messrs. A. Marshall and W. Roberts were re-elected, and the auditor, Mr. Weise, was also re-appointed, this bringing the meeting to a close.

Spiel's Patent Petroleum Engine Company, Limited.

THE first general meeting of this company was held on Monday at the offices, No. 1, Leadenhall Street. Mr. Heritage, who occupied the chair, referred to the fact that, although the company had only been in existence two months, the board had considered it wise to convene the statutory meeting. At the time the company was formed a special license was granted to Messrs. Shirlaw & Co., of Birmingham, who were to make the engines, the company also reserving power to manufacture. The board, however, considered it would be well to obtain the co-operation of Messrs. R. Hornsby & Sons, Limited, of Grantham, one of the largest engineering undertakings in the country. Both firms had now agreed to manufacture the engine under a royalty, and it was believed that the sale would be large. The board had also made arrangements for placing the manufacture of engines for South America in the hands of Messrs. Hornsby. This would be of great advantage to the company, but it had not been formed for supplying engines on the American Continent. The directors proposed that the company should acquire the patent rights for the continents of North and South America, reselling them to a subsidiary company to be formed on terms which would be very beneficial to the English company. This would be done without risk by the parent company, which would at the same time derive a substantial profit from the operation. A resolution to that effect was then adopted.

The Hammond Electric Light and Power Supply Company, Limited.—Mr. William Theobald, the liquidator of this company, has given notice that he is prepared to pay in full all admitted claims of creditors upon application at the office of Theobald Brothers and Miall, 23, St. Swithin's Lane, E.C.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 28th were £2,284, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of May were £1,688 against £1,352 in the corresponding period of last year.

PROCEEDINGS OF SOCIETIES.

Royal Society, May 27th.

"Researches upon the Self-induction of an Electric Current." By Prof. D. E. HUGHES, F.R.S.

Numerous researches have been made upon the self-induction of coils of wire, and but few in relation to the influence exerted by the nature and geometrical sectional form of the electrical conductor when employed in straight wires as in those of a telegraph line with the earth as a return, or those of a single wide loop where the distance of the return wire is sufficient to prevent any appreciable effect from the *mutual induction* of separate portions of the wire upon each other; our present theories class all non-magnetic metals together, taking only into account their specific resistance and the diameter of the wires; they admit, however, a certain modification in magnetic metals due to their magnetic permeability, but we have had but little experimental evidence of the effect produced.

The whole subject seemed to me worthy of experimental investigation, and I have lately* given the results of a first series of experiments made last year. I have remarked since writing that paper many new and important effects, and I have made a new series of researches, the results of which I wish particularly to point out in this paper.

* "Self-induction of an Electric Current in Relation to the Nature and Form of its Conductor," *Journal of the Society of Telegraph Engineers and Electricians*, January 28th, 1886.

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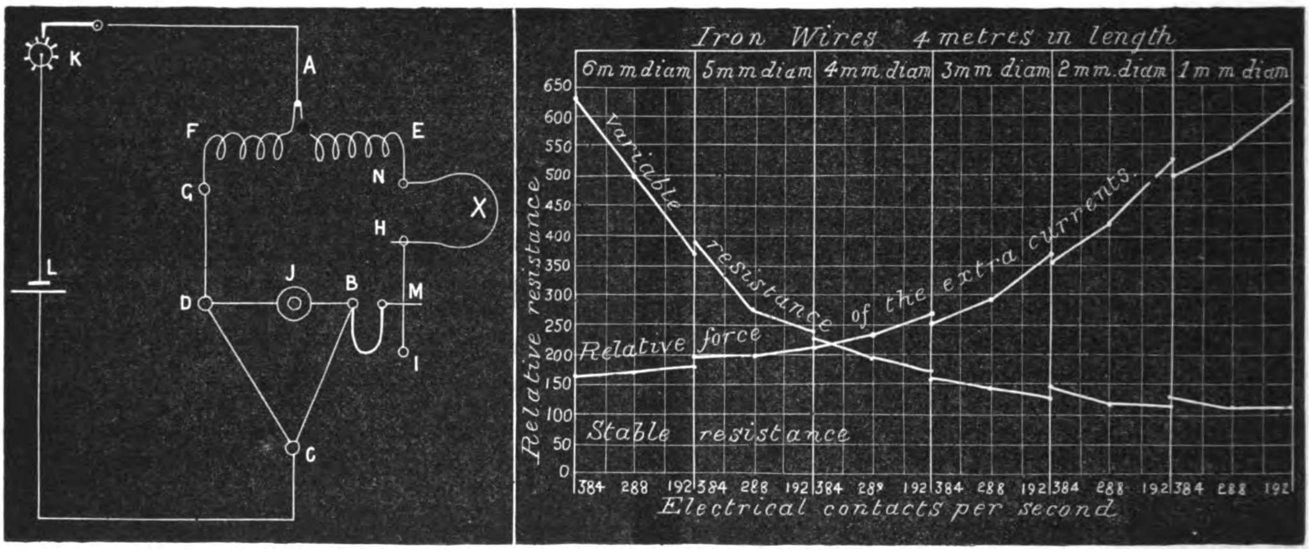
In my late researches I made use of a modified "Wheatstone's bridge" together with a portion of my "induction balance," by means of which the induced or extra currents from the wire under observation were balanced by a secondary current induced from an independent circuit; this gave excellent results, but the method has been criticised as having the fault of not being clear in its indications. In order to meet this objection and also verify the results which I had previously obtained, I constructed an entirely new bridge founded upon a most simple and well-known principle, and as the bridge admits of no change in the relative resistance of its sides, its action can be easily understood; it is with this instrument that I have made my new series of experiments.

The instrument consists of an ordinary Wheatstone's bridge, with the exception that a telephone replaces the galvanometer; there are in addition two coils of insulated copper wire, one in each portion of two sides of the bridge, by means of which the mutual self-induction of its convolutions can be increased or decreased as desired.

The electrical contacts are made either by a continuous periodic or tuning fork contact maker, or by a peculiar clockwork rheotome which I have made, in which a contact spring rests lightly on a wheel whose roughened surface is divided into eight equal parts of contact and insulation, by means of which we receive on the telephone eight equal periods of sound and silence each revolution of the wheel. We are by this means better enabled to appreciate feeble sounds than if they were continuous, and as the wheel can be made to revolve at any between two and 10 revolutions per second, we have from 16 to 80 periods of silence between each rubbing contact per second.

The following figure shows the theoretical plan of the electrical communications of the bridge:—



A, B, C, D are the four sides of the bridge, the telephone, J, replacing the ordinary galvanometer; the sides C, B and C, D are formed of German silver wire, each 50 cm. in length, 0·5 mm. in diameter, and 0·85 ohm resistance; the sides A, B and A, D have also 0·85 ohm resistance, so that the four sides have equal resistance, and this remains a constant during the whole series of experiments.

A, E and A, F is a continuous spiral of copper wire, formed of hard copper silk-covered wire of 1 mm. diameter and 4·80 metres in length, wound loosely on a boxwood cylinder of 3·50 cm. diameter and 30 cm. in length, on which it moves freely; the entire helix has 40 turns of 4 cm. diameter, each spiral being separated 5 cm. from each other; the spiral, however, is separated into two equal portions by giving a greater separation at the centre in order to allow it to be attached to a sliding collar of wood, by means of which we can press the spiral closer together on either side as desired; at E and F there are also adjustable collars of wood, and as the boxwood cylinder is graduated, we may (if the central collar is fixed) approach more or less either side of the helix, and read the degree of approximation of the coil, thus adjusting the mutual induction of each side to a perfect balance or zero. In practice I prefer moving the central collar, using the end collars only for the perfect adjustment of its zero, as we then have a double effect, viz., closing the coil say from A to F, increasing its mutual self-induction, and at the same time decreasing the previously balanced induction of the coil A, E, this not only gives a wider range of effect, but renders the scale readings more uniform; the end, F, of the helix is joined to about 10 cm. of German silver wire, completing the circuit from G to D; this supplementary German silver wire is simply for the purpose of making the resistance of A, D equal to D, C, and its length should be adjusted to this purpose; the end of the helix, E, joins directly with the terminal N; the wire to be tested, X, is joined to N and H; from H to I there is a second supplementary German silver wire allowing us by means of the contact side, M, which is in direct communication with B, to introduce more or less of the German silver wire in the side A, B. The resistance of the wire to be tested should always be less than that of the opposite side of the bridge, and we then make up the total resistance of A, B by sliding the contact slide, M, until the resistance of A, B equals A, D.

It will be evident that in the whole series of experiments there can be no change in the resistance of either side whenever zero is found, the induction coils or balance having the same proportional current in all the changes of the wires under observation, the battery and telephone circuit present also a continuous absolute relation; we may, however, when desirable, keep the resistance from H to M a constant, and vary the resistance or the length of the German silver wire, G, D, we then balance the wire, X, by an equal resistance on the opposite side of the bridge, but then the battery and telephone circuits no longer possess the invariable relations which are so extremely necessary in experiments of the nature of which I have been making.

The battery circuit is joined in the usual manner to A, C, the current can be interrupted by the rheotome, K, or by means of a commutator (not shown in the diagram) close the battery circuit, and transfer the contact maker to the telephone circuit, B, D; this allows us to observe the effect of an intermittent current compared with that of a constant or steady flow. M. Gaugain has termed the period of a steady flow of current the *stable period*, and that in which a rise or fall of the current takes place the *variable period*; these terms have since been generally adopted by telegraph electricians, and in order to avoid introducing new terms, they will be used in this paper.

It would require too much space to enter into the details of the construction of the bridge; special care is required in the construction of the balancing induction coils, and in securing perfect electrical contacts in all parts of the bridge; the induction balance requires calibration, and for this purpose I introduce as the wire, X, successive lengths of 10 cm. 1 mm. diameter copper wire, thus forming a table of values throughout the range of the induction balance, or by equal increments of 10 cm. of copper wire up to 20 metres.

Having no unit of self-induction to which my results could be quickly and practically referred, I have adopted as unit the self-induction of a straight copper wire 1 mm. diameter and 1 metre in length; this gives on my calibrated induction scale 100 degrees, and it is to this standard that all the comparative force of extra currents mentioned in this paper is compared.

The self-induction of a wire is proportional to its length, consequently a source of error might exist in the different lengths of the supplementary resistance wire, H, I, introduced to balance the resistance of G, D, but as we are enabled by the high specific resistance of German silver wire to obtain a very great change in resistance by a comparatively small movement of the sliding scale, this error in most cases of comparative experiments is but a fraction of 1 per cent., and when taken into account as it should be the error no longer exists.

The telephone used should be of the most perfect kind, and adjusted expressly for rapid and feeble sounds. I have found it best to employ an extremely soft Swedish iron diaphragm, without varnish or anything that can diminish or deaden the sound; its fundamental note should be higher than those generally in use, or at least 500 double vibrations per second, for we have to deal with extremely rapid effects which on short wires cannot be rendered evident upon a galvanometer, but which with a telephone in perfect adjustment are heard most distinctly with an electromotive force (?) in the battery circuit ranging from 0·001 to 0·250 ampère.

In the sketch of the communications the wire to be tested, X, is shown in the form of a wide loop, but in practice the instrument is constructed on two separate frames of wood articulated together at D, by means of which we can separate the terminals, N, H, and introduce straight wires, sheets, or tubes of lengths varying from 5 cm. to 1 metre.

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The object of my researches being to observe the self-induction which takes place in straight wires, or in those of a single wide loop where the reaction from any return wire is at such a distance that its influence is not appreciable, I shall, therefore, use the term self-induction to indicate the effects due to the electric current in its own portion of the wire, and mutual induction to indicate those where the reactions of different portions of the current and circuit react on each other, as in the case of coils; and although some theoreticians consider the two cases as the same, they are, as my experiments prove, entirely distinct, for we have, as will be shown, for copper wires a low coefficient of self-induction with a high mutual induction, whilst in iron wires the reverse is the case, for we there have a high coefficient of self-induction with an extremely feeble coefficient of mutual induction.

Influence of the Nature of the Conductor upon its Self-induction.

I found, as shown in my late paper, that there was a marked difference in the specific inductive capacity of iron and copper, and this entirely agrees with well-known theories; but I suspected that there might be some difference in the non-magnetic metals independent of their specific resistance. For this purpose I made a series of experiments with wires of the same length and diameter, but of different resistance. These showed a marked difference provided the current was increased in proportion to its diameter or conductivity, but no difference could be found when the current was kept a constant, and the interior differences in resistance of the wires were compensated by an external added resistance; but if we take wires of different metals—all of the same length and resistance, but of different diameters—there is a marked difference due to the mutual reactions of the current in its own wire, being less in wire of large diameter than in small wires. These effects have been fully explained in my late paper, and have since been completely verified by the method used at present. I showed by the use of my late method a critical point in the rise and fall of the induced currents; this is not shown by the present method of compensating by external resistance, but the rapid decrease in the electromotive force of the induced currents, as indicated by the induction balance, is well shown by the present method. The following table shows the observed force of the extra currents for wires of the same length (1 metre), but of different diameters:—

	mm. 0·25	mm. 0·50	mm. 1·00	mm. 2·00	mm. 3·00	mm. 4·00	mm. 5·00	mm. 6·00	mm. 7·00	mm. 8·00	mm. 9·00	mm. 10·00
Iron ...	760	621	530	360	269	220	190	171	152	138	128	124
Copper	129	113	100	89	82	78	75	73	72	71·5	71·2	71

The fall in force is now even more rapid than shown by my late method, and it will be seen that iron is peculiarly sensitive to an increase in diameter, having nearly six times the force of copper in wires of 0·25 mm., and not twice the force of copper in wires of 10 mm. section.

Reactions of an Electric Current in its own Portion of Conductor.

The phenomenon of a constant decrease in the electromotive force of self-induction, as measured by the induction balance, with each increase of the sectional area of the conductor, is well shown by the present method, and an experimental investigation of its cause has shown that we should not consider a current in a wire as a single element reacting solely upon exterior wires, but that the current acts precisely similar as would an infinite number of independent streamlets of current reacting upon each other in the interior of its own wire similar to their known effects upon exterior wires. My experiments demonstrate this to a degree that leaves no doubt on my mind as to its truth, for according to this view we should be able to reduce the self-induction to a very great extent by employing thin flat sheets where the outlying portions are at a comparatively great distance from the central portions. This I have experimentally proved to be the fact, but this experiment alone does not show if the reduction of self-induction is due to a different arrangement of the current in sheets as compared with solids. If the reduction is due to the greater separation of the streamlets, then we should be able to reduce this induction in a still greater degree by employing a conductor composed of numerous small copper wires through which the current is equally divided, and which could be separated or brought close together as desired. This proves to be also an experimental fact, for the conductor formed of numerous strands has far less self-induction than a thin sheet when its wires are separated, so that they can no longer react on each other, and surpasses the thin sheet and approaches the value of a circular wire when these wires are brought near together, so that their mutual reactions can approximate those of the numerous streamlets in a solid conductor.

Iron shows a still greater reduction in its self-induction when in the form of thin flat sheets or numerous small iron wires separated from each other, with the exception that we cannot restore or approach the value of a solid wire by bringing them in close proximity. The reduction of the induced currents by employing thin sheets instead of a wire is so great in iron that we could not account for it on the mere separation of contiguous portions of the same current, but if we assume that the comparatively high force in iron wires is due to the induced circular magnetism, and that this almost disappears in flat sheets, we account for the fact that a thin flat sheet of iron has less inductive capacity than a similar sheet of copper of the same resistance, but of different widths; and if thin strips of copper, brass, lead, and German silver are compared with similar iron strips, and their resistance rendered equal by the added resistance in the bridge, no difference is found between iron and the non-magnetic metals, for under these conditions their inductive capacities appear equal.

Reactions of an Electric Current between Separate Portions of the same Conductor.

In order to distinguish two distinct effects I have defined self-induction as the effect produced by an electric current on its own portion of the wire, and mutual induction as the effect of the reactions between separate portions of the wire on each other.

The mutual induction in iron and copper wires is very different in degree, as shown by the following table:—

TABLE I.

Wires, silk-covered, 1 m. in length, 1 mm. in diameter.	Comparative force of the extra currents.	Strips or ribbons, silk-covered, 1 m. in length, 10 cm. wide, 0·1 mm. thick.	Comparative force of the extra currents.
Copper wire, in a single close loop where each side is in close proximity	18	Copper strip, in a single close loop where each side is in close proximity...	14
Copper wire, in a single wide circular loop	100	Copper strip, in a single wide circular loop	60
Copper wire, in a coil of 3 cm. diam., having ten layers in close proximity ...	607	Copper strip, in a coil of 3 cm. diam. having ten layers in close proximity ...	580
Iron wire (soft) in a single close loop, as above...	440	Iron strip (soft) in a single close loop, as above	16
Iron wire, in a single circular wide loop ...	502	Iron strip. in a single circular wide loop...	60
Iron wire, in a coil as in the case of copper	570	Iron strip, in a coil as stated for copper ...	578

There is a remarkable fall in the induction of a straight wire or single wide loop of a copper wire when this wire is doubled upon itself as a return wire in close proximity. The effect of mutual induction is also shown by the equally remarkably rise when the mutual induction of ten layers of a coil react on each other. This is well known, but what I believe has not yet been experimentally observed is the remarkably feeble mutual induction of iron wires, either when in parallel return in close proximity or when in coils of numerous layers. The percentage of increase of induction in a copper wire from a wide single loop to that of the ten layers being 507 per cent., whilst in iron under precisely the same conditions there was an increase of but 13·6 per cent.

That this remarkable difference as shown between the mutual induction of iron and copper wires is due entirely to the circular magnetism in the iron wire, and that the mutual reactions of the streamlets of the current in a thin flat iron conductor prevent this formation I have proved in various ways, for if the circular magnetism is the cause, flat iron sheets which have as low self-induction as copper should be equally sensitive to mutual induction as the non-magnetic metals, for they no longer in any appreciable degree possess the protecting magnetic sheath which enfeebles the mutual reactions of iron wires upon each other; this proves to be the case, a thin ribbon of iron having the same coefficient of mutual induction as copper, and it no longer behaves as a magnetic body.

Table I. shows the difference in the mutual induction of iron wires and strips; it will be seen that when the iron is in the form of a wire the circular magnetism produces a marked difference between iron and copper, whilst in the form of flat strips the iron resembles copper (as regards mutual induction) in every respect.

Influence of Circular Magnetism.

I have shown in my late paper that an iron conductor composed of numerous fine stranded wires (as in a rope) behaves like copper, and this I regard as entirely due to the breaking up or prevention of circular magnetism; I also showed a phenomenon which I could not then explain, viz., that when an iron wire was heated to a yellow-red heat it lost its previous high specific inductive capacity and behaved like copper. The effect of heat upon magnetism is well known, consequently we can readily explain the fall in its inductive capacity by the disappearance of its circular magnetism. I found also that in thin flat strips of iron there was no change whatever in its inductive capacity at the yellow-red heat; this can now be readily explained: it behaved like copper when cold, and, having but little circular magnetism to destroy, there was no appreciable change produced, except that due to the extra resistance caused by the increased temperature of the strip, and to which copper and iron are almost equally sensitive, consequently we may consider iron (when in the form of thin flat sheets) to behave like non-magnetic metals throughout all temperatures.

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Influence of Self-induction on the Resistance of the Conductor.

A phenomenon of great importance is the effect which I have observed of the resistance of a wire being greater during the rise of the current, as in the variable period, than that measured or known during the constant flow, as in the stable period; by resistance I mean a pure ohmic resistance, a resistance which can only be measured, expressed, or balanced in ohms, and, whatever the cause, the effect is one of pure ohmic resistance.

We can imagine that at the first moment of contact there is no current flowing through the wire, its resistance is then infinite, but the current gradually increases in force until it arrives at its maximum, as in the stable period. We have thus between the moment of contact and period of steady flow a variable period wherein the resistance falls in the form of a curve from infinity to its well-known stable resistance; the telephone is unable to give the exact form of this curve directly, but it gives by the nul method comparative results as to the different duration in time of the curve in different metals.

If we take a straight copper wire 1 metre in length and balance its resistance in the stable period, we shall find that there are only traces of a difference in its resistance in the variable period, and we can balance its self-induction by the induction balance; but if we replace the copper by an iron wire of the same length, or even a much shorter wire, viz., 20 cm., we find that in the variable period we can no longer balance the wire by the induction balance alone, but we must compensate for its increased resistance by the sliding scale, the amount of subtracted German silver wire expressing in fractions of ohms (the value of the wire being already known) the additional resistance of the iron wire in the variable period; we can thus reduce or balance the iron wire to a perfect zero, provided the current from the battery does not exceed 0·10 ampère; but with greater current there will still remain a slight muffled sound, which cannot be reduced to zero either by the induction balance or the resistance slide. It therefore became important to determine if this muffled sound was due to a difference in resistance which could not be balanced, or to the lengthened duration of the extra currents being slower than the balancing current from the induction balance; the latter proved to be the case, for on prolonging the duration of the balancing currents from the induction bridge by introducing a core of iron in its coil, the balance or zero became absolutely perfect. In this case we must choose between cores of different diameter to find one whose reaction on the time effect of the induction coil equals the retardation of the extra currents in the wire tested.

If we observe the method employed in the bridge, we shall see that the induction balance can balance the extra current of the wire, X, irrespective of the position of the resistance slide, M, or any relation between the sides A, B and A, D, but we cannot equalise the resistance of these sides except by the necessary adjustment of the resistance slide, consequently when we are forced to adjust the induction balance we are compensating the extra current, and when we are forced to move the resistance slide we are balancing resistance.

The disturbance in the bridge caused by the change of resistance of the wire tested in the variable period, causes a momentary primary current to pass through the telephone in the same direction as the extra current, and if these are not separated by balancing the extra current by an induction balance, the mixed effect would be read as a single effect of the extra current. To show the importance of separating these two effects, it is only necessary to say that in most of the cases cited in this paper the momentary primary current due to the extra resistance greatly exceeds that of the extra current; consequently all measurements taken wherein this separation is not complete, gives the result of a mixed effect.

(To be continued.)

The Society of Telegraph-Engineers and Electricians.

An ordinary general meeting of this society was held on Thursday, May 27th, Professor HUGHES, F.R.S., President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members announced, it was stated that Mr. Leonard Wray had presented to the society a number of botanical specimens of gutta percha plants obtained from Perak. A paper was then read by Captain P. CARDEW, R.E., member, on "The Telephone as a Receiving Instrument in Military Telegraphy."

I have been asked to give you a short account of the system of telegraphy with vibration currents, using the telephone as a receiving instument, which was invented by me five years ago, and has since been used with considerable success in several campaigns.

Shortly after we became possessed at Chatham of any really well-made telephones, the idea of using them as receiving instruments, for telegraph messages sent by the ordinary Morse code, struck Major Armstrong, who was then in charge of the Electrical School, as probably applicable to field telegraphy, where interference from induction from parallel wires was not to be apprehended, and where the extreme sensitiveness of the instrument would probably enable work to be carried on in spite of faults of insulation, hasty joints, bad earth connections, &c.

This idea was worked at for some time. It was found that there was some difficulty in reading, due to the almost perfect similarity of the make and break clicks in the telephone and the consequent liability to read the signals reversed. Still, this was probably to be overcome by practice, and eventually it was determined to try through what length of bare wire laid on the ground without any insulation the method would admit of carrying on work.

Some experiments had also been carried out at this time with some vibrating sounders* sent for trial by Messrs. Theiler.

These are on the same principle as an ordinary chattering bell, but arranged to give a musical note.

They were intended to be used as ordinary sounders, but the difficulty was, that they interfered with each other if more than two were used on one circuit.

The following is an extract from a report I made to the Royal Engineer Committee on the experiments carried out with this bare wire:—

"Report of an equipment with 15 miles of bare wire laid on the ground, with a view to ascertain the possibility of signalling through it by means of telephones.

"Telegraph School,
"School of Military Engineering, April, 1881.

"The wire consisted of 10 miles of No. 16 B.W.G. soft iron galvanised wire, and 5 miles of No. 16 B.W.G. copper wire. This arrangement possessed the disadvantage of keeping a continuous current on the line from the earth contact of the two wires, and of tending to destroy the iron wire, but, as the line was only required for a short time, this was not material.

"Permission was obtained from the authorities of the London, Chatham, and Dover Railway, to lay the wire at the side of their line of rails. It was consequently laid in a loop extending from a short distance on the up side of the New Brompton Station to within a short distance of Newington Station, and back again on the other side of the line.

"To ensure the wire being well out of the way of the traffic, it was laid in the *hedges* in many places. In other places it was laid on the ground, even picketed down under stiles so as to prevent its tripping people up. The ground was generally newly made or garden ground, and the soil of fair conductivity. Rather more than half the wire was thus laid in the hedges.

"At road crossings the wire was stretched over a pole at each side.

"For convenience, one end of the wire was brought into the R.E. Institute.

"This necessitated using poles to avoid interference with traffic, and for convenience some poles carrying existing lines were made use of. This introduced induction signals, so that, in getting signals through, the following difficulties had to be contended with, viz.:—

"1. Very bad insulation.

"2. Continuous current from the different metals in the line wires and earths employed.

"3. Induction currents confusing signals.

"The line resistance was never accurately obtained, this being impossible under the conditions, but it must have been about 900 ohms, while the insulation test from the institute gave on several days a resistance as low as 300 ohms, which of course included part of the line resistance, the position of the resultant fault being at any rate some distance beyond the end of the insulated wire, so that the true insulation resistance must have been extremely low.

"The first intention was to use the telephones as Morse instruments with an ordinary key as before proposed, the connection being as shown in fig. 1.

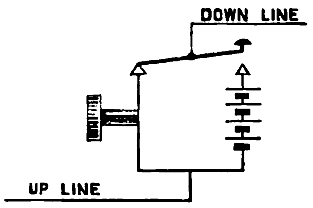

FIG. 1.

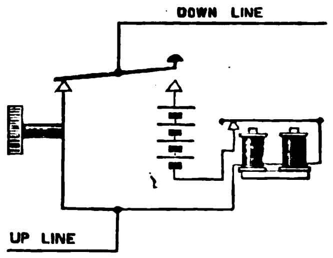

FIG. 2.

"This was tried with batteries of 10 Leclanché cells at each end. At the institute, in a quiet room, there was no difficulty in reading these signals, but the ear had to be kept quite close to the instrument. At the other end there was some difficulty in reading signals when first tried, owing to a very high wind producing noises in the telephone. To get over this I tried the effect

* See ELECTRICAL REVIEW, February 15th, 1879.

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of putting on a Theiler Sounder, as in fig. 2, thus sending a vibratory current out to line."

"This was completely successful, the note produced being very easily read and quite distinct from the induction signals, and the noises due to earth currents.

"Signalling was carried on for several days by this method, without any difficulty, clearly demonstrating that by this means signalling can be kept up through bare wire laid on the ground (as rapidly as cable), and afterwards poled and insulated when circumstances permit.

"Another advantage of this use of the telephone is, that no adjustment of the receiving instrument is ever necessary, thus eliminating a fruitful source of delay.

"For ordinary insulated lines the battery power required is very small, and the telephones are ready when necessary to be used in the ordinary way, and would no doubt be found very useful by the general and his staff as a means of personally communicating orders."

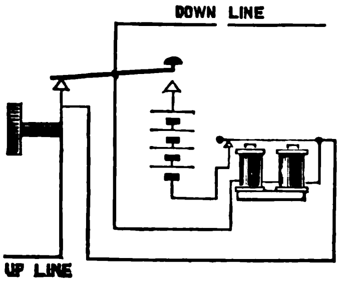

FIG. 3.

"Another method of connecting the Theiler Sounder is shown in fig. 3. This I think preferable to fig. 2 in general, for the following reasons:—

"1. The current through the Theiler sounder is practically uninfluenced by any change occurring in the line resistance.

"2. In the case of a dirty back contact in the key (a fault of frequent occurrence causing much delay), continuity will still be established through the coils of the Theiler sounder.

"3. Fewer cells can be employed (four cells Leclanché being quite sufficient for ordinary circuits).

"The note given by the Theiler sounder in the telephone is quite as loud as the tone of the ordinary sounder under ordinary circumstances. When working through bare wire laid on the ground it is of course low, but still quite distinct if held close to the ear.

"A simple apparatus for holding the telephone in the required position, so as to leave the arms free, could be easily designed. Two telephones, one to each ear, might then be advantageously employed.

"From the results of this experiment with bare wire, I feel confident in recommending the employment of this combination of Theiler sounder and telephone in place of the ordinary sounder for field service, over which it possesses the following advantages:—

"1. The possibility, as demonstrated, of working through a considerable length of bare wire.

"2. The receiving instrument requiring no adjustment for altered conditions of line and different stations, &c.

"3. The reduction of the battery power required to be carried to at most one-fourth of the present requirements.

"4. The continuity of the line being ensured, independently of the back contact of the key.

"5. The power of working through very bad earths, saving much time in very dry places.

"6. That the note signals are more easily read than the interval signals by men untrained to either."

Experiments were immediately afterwards carried out by the field telegraph troop at Aldershot with this system, which was reported on very favourably by Colonel (then Major) Hamilton, R.E., commanding the troop, from whose report I need only extract the following paragraph:—

"I should add to the above, that the experiment was tried of poling the line which had been laid on the ground while messages were being sent through the line, and the poling did not in the least interfere with the reading of the messages. It therefore follows that a line of bare wire may be laid as fast as an army advances, and that a party may follow slowly and pole the line; the communication being established from the first laying out of the line."

An extensive trial of the system was in consequence approved. Rather unfortunately, in order to save expense, it was proposed to convert the existing old pattern field sounders into Theiler or vibrating sounders. These instruments were mostly in a shaky condition, and in consequence were liable to get out of adjustment when used as vibrators, for which purpose it is essential that all parts of the instrument, except the vibrating tongue, should be very firmly fixed.

Some of these converted instruments and telephones were taken out to the first Egyptian expedition, in 1882; and this system was used exclusively in sending the messages from the field of Tel-el-Kebir from 8·30 a.m. to 6 p.m.—115 messages, averaging 30 words each, being recorded as having been sent during this time, while some messages were unrecorded.

A new pattern of vibrator was, however, then considered essential. As the noise made by the vibrator and the telephone at the sending end was sometimes a nuisance, it was reduced to a minimum in this instrument by using a very light armature—simply a piece of ferrotype or tinned iron—and by means of this small key at the side of the signalling key which, when depressed by one finger, short-circuited the telephone.

It was considered desirable to practically determine, if possible, the limit of distance to which the system was workable on a long aerial line isolated from other wires. As this could not be obtained in England, the Indian Government was asked to try the experiment, and the following is an extract from the report of the electrician of the Government Telegraph Department:—

"Weather clear and fine.

"Worked Tuticorin, a distance of 375 miles, by wire from Calicut, with 30 Minotti cells, reducing battery subsequently to four cells. Signals from Tuticorin very clear, and could, with the stronger current, be read on telephone held at some distance from the ear; but with the weaker current it was necessary to hold the telephone pressed against the ear.

"The thick, or No. 1 armature, was used at both ends throughout.

"The two parallel wires to Beypore (9 miles), and Malapuram (18 miles), also line to Vayitri and Tellicherry, were working at the same time, and all together during the above experiments, the two latter being suspended on same posts as the others, for a distance of ten yards from the office only.

"The beats from the offices working as usual were distinctly audible in the telephone, but, except when the weaker battery of four cells was on, the signals from Tuticorin on the vibrator were not interfered with—the musical not riding above the induction beats. Following day, weather cloudy and some rain.

"Worked Tuticorin at 7 hours, beginning with 10 cells and decreasing to two cells. The lines were disconnected at Cochin, 125 miles from Calicut, and the ends of the wires thrown down and, lying on wetted floor of signal room, worked well with 4 cells."

This clearly shows that, with an insulated aerial line, very great distances could be worked by this system without translation.

In 1883, some experiments on General Post Office wires were made with this system, of which the following is a condensed report:—

"*1st Experiment.*—New Cross to Chatham (30 miles), worked easily with one cell, and very good signals with 6 cells; also worked through wet string and human bodies.

"*2nd Experiment.*—New Cross to Bristol 123 miles on poles and eight underground. Chatham to Bristol, 158 on poles and ten underground—wires on the same poles—could hardly get through with 60 cells.

"Ordinary apparatus worked with 30 cells.

"The vibration currents were destroyed by induction, especially in the underground part through London.

"*3rd Experiment.*—Two parallel wires between New Cross and Dover, with vibrators. New Cross could read messages sent on both circuits simultaneously. Dover was not so successful, chiefly because the operators were not accustomed to read by sound. Signals audible with two cells and good with 5—67 miles open and two miles covered.

"*4th Experiment.*—Two parallel wires between New Cross and Chatham, fitted with ordinary ink-writers, also between the two vibrators and condensers."

This was an idea of mine to get an independent vibration circuit superposed on ordinary working, and was quite successful—all three circuits working quite independently. Signals audible with two and good with 10 cells on vibrators—30 on the Morse.

In place of the condensers an ordinary plate lightning protector was fitted, and afterwards a resistance of 10,000 ohms, without interrupting the working.

"*5th Experiment.*—New Cross to Chatham. To each end of one of the wires, between New Cross and Chatham, both vibrators and Morse recorders were connected, the vibrators being separated from the line wire by the plates of condensers.

"When Chatham sent simultaneously on both his instruments (separate messages, of course), New Cross could read on both his; but when Chatham sent on his vibrator at the same time as New Cross sent on his Morse instrument, the signals could not be read but became mixed up and confused.

"*6th Experiment.*—Two wires known as 197 and 198 were tapped at Bristol station and Paddington (118 miles apart); these wires were not cut or terminated, they were carrying powerful currents from the General Post Office to stations in the West of England and South Wales.

"Between them, as in experiment 4, were placed vibrators and telephones.

"The experiment was a failure, as, owing to the strength of the working currents, the signals in the telephones were completely overwhelmed by the noise of the induced currents. Occasionally, at intervals, the signals sent from Paddington were audible for a moment.

"*7th Experiment.*—One wire, 193, running parallel to the above, was cut at Bristol and Paddington, and vibrators and telephones fixed upon it. Communication was carried on, in spite of the induction from the neighbouring wires.

"*8th Experiment.*—A cable containing seven wires runs between Dublin and Holyhead, about 65 miles. Six of these carry the ordinary postal telegraph business, the seventh is 'dead,' *i.e.*, has become so earthy that none of the ordinary telegraph instru-

ments will work it. Vibrators and telephones were accordingly placed in connection with this dead wire; owing to the induced current from the other wires communication could not be carried on until the working upon them had been temporarily suspended. As soon as these currents ceased, however, messages were successfully exchanged over the 'dead' wire by the vibrators.

"*9th Experiment*.—A bare G.I. wire was laid alongside of the railway on the ground, from Chatham to Faversham, about 16 miles—it was in contact with the railway signal wires and with stay wires, and piles of sleepers and of railway iron, which had been deposited upon it—vibrators were, as before, joined to it: at first no satisfactory results were obtained; the wire was cleared from contact with the signal wire and some of the stays, and afterwards communication was successfully established, interrupted sometimes by the noise of passing trains."*

In commenting on these experiments, on October 1st, 1883, I remarked: "It is worth consideration, whether the system of working tried successfully in experiment 4 could not be usefully adopted in the postal telegraphs. . . . . The method is much improved by the addition of magnets on the Morse circuit, as the Morse clicks can be practically softened off in the telephone to such an extent, by being passed through the coils of a magnet, as to avoid all interference with the vibration signals."

Immediately after this I tried the effect of working as in experiment 5, but with the addition of an electro-magnetic coil of considerable inductive power, on each end of the line, between the Morse instruments and the vibrators, and found it work perfectly.

This method was soon afterwards tried between New Cross and Chatham, and worked perfectly, although the condition of the line was so bad and variable that we could not succeed in duplexing the Morse. By this method, therefore, two independent circuits can be at once established on a single wire with single instruments, without any balancing or nice adjustments.

Of course it is evident that the system is practically the same as Van Rysselberghe's, but it was brought out quite independently, and in the manner detailed; and the fact that he can successfully employ it with the weak speaking currents shows how certainly it must work with the far more powerful vibration currents.

Although the separators were not tried either in Bechuanaland or Egypt, the vibration system was found very useful, notably in one case in Egypt, where working was carried on for six weeks through a bare wire laid on the ground for a distance of 23½ miles, from Kaibar to Abu Fatmeh, and absolutely buried for a distance of 200 yards through the camp at Kaibar. This distance is rather longer than that worked through in England, viz., from Chatham to Faversham; but it was not really so severe a case, as the ground in the Soudan was decidedly dry, and that in England distinctly wet. The most noteworthy feature of this trial is that only two small Leclanché cells were used at either end, and that with this small battery-power, through a line making dead earth all the way, the call signal was audible, even without holding the telephone to the ear.

The vibration system is now applied by us in many ways. For instance, with ordinary telephones a buzzing armature is fixed to the induction coil, causing a vibratory current in the primary circuit, which is reproduced as a call signal in the telephone, thus dispensing with the ordinary bell. The note is loud enough to be heard in an adjoining room.

I have also adapted it to an instrument for testing lightning conductors.

The instrument was got out before the publication of our President's most valuable researches in the field of self-induction, and I do not see my way to obtaining anything better than a minimum of note when arranged for balancing very low resistances. A sonometer has since been added to it, the effect of which I have not yet tried, but which I expect will overcome the difficulty.

We are not yet quite satisfied with our pattern of vibrating transmitter, and Messrs. Theiler, who unconsciously produced the first one, have recently brought out an improved pattern, which, with some modifications, will probably be adopted.

It is worked on a primary low resistance coil, and the secondary coil throws an alternating induced current on line.

I had never taken to this obvious modification, except as a call signal for telephones, as the simpler form enabled increased battery-power to be more effectually used, but the power of the purely induced current in the telephone is certainly marvellous, and this pattern, with three cells, has given as loud a note as our present pattern with ten cells, under all conditions of artificial line.

The last instrument I submit to-night is a "Combination Box," adapted for speaking or telegraphing.

The vibrating transmitter is double wound and acts as an induction coil for the transmission of speech. The microphone transmitter used is a "Hunnings" or "Moseley," arranged with a handle which forms a switch. This solution of the switch difficulty, which gave us some trouble, is due to Quartermaster Sergeant Kenney, R.E., and is certainly the most efficient we have yet tried. It performs two offices: when speaking, it is squeezed in the hand and completes the circuit through the microphone and primary coil; when listening the pressure is relaxed, the battery circuit is broken, and the secondary coil short-circuited. Thus the battery circuit is never kept on longer than is absolutely necessary, a most important point in the field, where small patterns of cells must be used and renewals may not be at hand.

In the discussion which followed the reading of the paper,

Major BERESFORD, R.E., said that he considered that Captain Cardew was working in the right direction as regards field telegraphy. The question of outpost telegraphs is a most important one. The employment of Captain Cardew's method of working a telephone on an ordinary circuit was valuable, inasmuch as only one wire could be used for a field telegraph. The only objection to the Theiler sounder was that the buzzing sound was trying to the ears.

Mr. VON FISCHER TREUENFELD would ask as to the admissibility of a telegraphic apparatus for field purposes which left no record. Opinions on this point differed greatly. In the German army a recorder was considered to be an absolute essential, and General Von Chauvin in a work on Field Telegraphy had emphasised this. A more recent writer had gone so far as to ridicule the idea of a non-recording instrument. Personally he (Mr. Treuenfeld) was in favour of sounders and especially of buzzing sounders, as they can be worked through uninsulated wires and consequently enabled a line to be brought well to the front.

Dr. JACQUERS had noticed for years the inductive disturbances which took place on telephone wires and had made a practical use of the fact. Telegraph signals could be distinguished on telephone wires which were several miles distant from the telegraph wires. He had had specially erected two wires, each half-a-mile long and six miles distant from each other, and the signals on one could be distinctly heard on the other.

Mr. DONOVAN pointed out with reference to recorders *versus* non-recorders for field-telegraphs, that non-recorders were exclusively used during the American civil war.

Mr. PREECE said that he could endorse all that Captain Cardew had said. He was himself greatly interested in the experiments, since they involved the question of increased capacity for the wires. The objection to the buzzing sounder was, that inasmuch as the Wheatstone transmitters ran at a rate which gave 200 vibrations a second, the sounds from these might overpower or confuse the ordinary buzzer sounds and it would be impossible to superimpose telephone signals on these. The underground wire difficulty would also have to be considered. As regards the increase of working capacity which the Cardew system admitted of, it was somewhat curious that in cases where two wires were available to enable the system to be carried out, an increased capacity was not wanted. He would mention that the Delany multiplex system enabled the working capacity of two circuits to be increased to that of twelve. The vibrating call to which Captain Cardew had alluded had been adopted in the Postal Telephone exchanges to call up a subscriber who had left his call bell disconnected by not replacing the telephone tubes back on the switch hooks.

Captain CARDEW in replying said that Mr. Donovan's statement with regard to the use of non-recorders during the American civil war was an answer to Mr. Treuenfeld. The experience of the Egyptian campaigns, also, had not proved that a recorder was required. Experiments had been tried across the Solent with reference to telegraphing by induction on the principle of the experiments referred to by Dr. Jacquers.

A paper was then read by Captain H. R. SANKEY, R.E., member, on "A Problem relating to the Economical Electrolytic Deposition of Copper."

In the discussion which followed the reading of the paper,

Colonel STODDART, R.E., said that the first experiments tried at Chatham with dynamos in the place of Smee batteries for electroplating were not satisfactory, but subsequent improvements resulted in such success that the deposits obtained were far superior to those obtained from a battery. The whole of the details were worked out by Captain Sankey.

Mr. BERNSTEIN stated that in Germany there are more than six works in which more than a ton of copper is deposited per day by electric power. The copper obtained is of very high conductivity. As regards the cost of deposition, when the copper is required in quantities, it is cheapest to use a comparatively strong current, though this strong current cannot be increased indefinitely.

Prof. FORBES considered that the whole question could not be reduced to the mathematical perfection suggested by Captain Sankey, as the number of cases to be dealt with were very numerous indeed. From an examination made at Messrs. Lambert's works at Swansea, where copper was extracted from the ore, in order to leave the gold and silver, he had come to the conclusion that most economical and satisfactory results were obtained with one tank, and a very low electromotive force, as the plates can be taken out just as required without interference with the rest of the circuit. The proper dynamo to use is one to give enormous quantity with very low electromotive force. He stated with confidence that in the future copper kettles and pans would be manufactured by electro deposition at a cost of only a few pence per pound, instead of, as at present, at a total cost of eighteen pence. The coppering of ships' bottoms would also, he believed, be effected by electro deposition.

Captain SANKEY, in reply, stated that his intention was not to give a general solution of the whole problem, but to assist only to that solution. As regards the single tanks being cheaper than a series, the factors in the mathematical investigation prove this to be the case, but the leads bring up the expense.

* Attempts were made to work along the bare wire with the ordinary Post Office relay. Signals could not be obtained further than about a mile.

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At the termination of the discussion,

The PRESIDENT announced that it was proposed to hold the annual conversazione at Portsmouth, and by the kind permission of the Admiralty the dockyard, &c., would be viewed; the date would probably be about June 29th.

The meeting then adjourned.

Physical Society, May 22nd, 1886.

Professor BALFOUR STUART, President, in the Chair. Messrs. C. A. Bell, W. C. Johnson, and James Swinburne were elected members of the Society. The following communications were read:—

"On the sympathetic vibrations of Jets." By Mr. CHICHESTER A. BELL. It has been assumed hitherto that a gaseous or liquid jet vibrates under the influence of a limited range of tones only; effective tones being those which do not differ greatly in pitch from the normal or proper tone of the jet, discovered by Savart and Sondhauss. The author has found, however, that when the pressure under which a jet escapes is not too great, the latter is affected by all tones lower than the normal, as well as by some above it. Changes may be excited in a jet of either kind by vibratory motions of the jet orifice, or of the fluid behind, or external to the orifice. These changes take the form of slight swellings and contractions, which become more pronounced as the fluid travels away from the orifice, and finally cause the jet to break or become discontinuous at a distance which depends upon the intensity of the initial disturbances. At any point within the continuous portion of the jet the successive swellings and expansions represent both the form and the relative intensities of vibrations impressed upon the orifice; and the jet is, therefore, capable of reproducing very complex sounds, such as those of speech and music. A vibrating jet of air does not, however, emit sound when it plays into free air, or into the wide end of a tube communicating with the ear, but when it plays against a very *small* orifice in the end of a hearing tube, loud sounds may result. This reproduction is most intense when the hearing orifice is placed in the axis of the jet, just within the breaking point; but becomes gradually feebler as the hearing orifice is moved towards the jet orifice, or out of the line of its axis. Beyond the breaking point the sounds from the jet at first become confused, and finally are lost. A jet of gas, like a liquid jet, only vibrates so as to produce its normal tone when it strikes upon some obstacle which serves to diffuse the disturbances due to impact, or throw them back upon the orifice. The vibrations of an air jet are also loudly reproduced as sound, when it is directed against a small flame below the apex of the blue zone. Liquid jets are but slightly sensitive to aerial sound impulses, but become highly sensitive when the jet tube is rigidly attached to a sound board. The vibrations of a jet so mounted are best perceived as sound when the stream strikes upon a rubber membrane tied over the end of a narrow tube which communicates with the ear. For accurate reproduction of speech and sounds in general the jet should be at such a pressure as to respond visibly to a note of about 4,000 vibrations per second; and the membrane should be at such a distance from the orifice that the jet never breaks, and becomes discontinuous above its surface. The vibrations of very fine jets of any conducting liquid become clearly audible when a portion of the jet, or the "nappe" formed when it strikes upon a flat surface, is included in circuit with a battery and ear telephone. This may be accomplished by letting the jet impinge on the end of an ebonite rod, through the centre of which passes a platinum wire; the upper end of the rod is surrounded by a short tube or ring of platinum, the upper margin of which forms a continuous, slightly convex surface with the exposed end of the central wire and the ebonite. The wire and ring form the terminals of the circuit, which is completed through the "nappe." Distilled water containing $\frac{1}{300}$th of its volume of pure sulphuric acid is recommended as the jet liquid.

The author advances a new theory to account for the growth of the vibratory charges in liquid and gaseous jets.

"On some Thermodynamical Relations." Part V. By Professor W. RAMSAY and Dr. S. YOUNG. In parts I. and II. of this series of papers it was shown that the ratio of the absolute temperatures of any two bodies corresponding to a given vapour pressure bears a simple relation to the ratio at any other pressure, which may be expressed by the equation $R^1 = R + c(t^1 - t)$; where R^1 and R are the two ratios, c is a constant, and t^1 and t are the temperatures of one of the two bodies. The determination by Schumann (Pogg. Ann., N. F. 12, 46) of the vapours of methyl formate, and 27 homologous ethers, made it possible to compare the vapour pressures of a large number of bodies belonging to the same class. It was found that when the ethers were compared with ethyl acetate, which was taken as the standard, in every case $c = o$, and therefore $R^1 = R$. The pressures corresponding with the three pressures, 200, 760, and 1,300 mm., are given by Schumann. Taking the mean value of R for those pressures as correct, and recalculating the temperatures, the greatest difference between the found and recalculated temperatures is 0·7° C. The vapour pressures of water or any one of the ethers being accurately known, it is sufficient to determine the boiling point of any ether belonging to this class, in order to construct its vapour pressure curve. The absolute temperatures corresponding to the pressures 200 and 1,300 m.m.x. for any ether are ·89795 t and 1·0488 t, where t is the boiling point at normal pressure in absolute temperature.

A Grid-iron slide Rule, by Mr. Stanley, designed by Mr. Thacker, was explained by Mr. C. V. BOYS. It was equivalent to a slide 60 feet long, and performed multiplication and division with an error not exceeding the $\frac{1}{100000}$th part.

Specimens of safety explosives, and their results in shattering blocks of lead, were exhibited by H. SPRENGEL.

NEW PATENTS—1886.

7080. "Arc electric lamps." W. R. JOHNSTON. Dated May 26.

7107. "Holders for incandescence lamps." R. A. SMITH. Dated May 27.

7109. "Electro-telephonic apparatus." A. A. C. SWINTON. Dated May 27.

7147. "Galvanic batteries." E. TUTEUR. Dated May 27.

7151. "Holder for the reflector and shades of incandescent lamps." A. L. FYFE. Dated May 27.

7177. "Electric measuring instruments (ampère and voltmeters)." R. ALIOTH & Co. Dated May 28.

7189. "Primary voltaic batteries." J. E. PEARCE. Dated May 28.

7251. "Making carbon filaments, &c., for incandescent electric lamps." W. MAXWELL. Dated May 31.

7270. "Combined dynamo-electric machines and motors." P. W. WILLANS. Dated May 31.

7277. "Dynamo-electric machines." A. LE N. FOSTER, F. V. ANDERSEN. Dated May 31.

7279. "Regulator for high tension electric currents." A. H. BYNG. Dated May 31.

7294. "Globes or receptacles for electric lamps." F. H. VARLEY. Dated May 31.

7311. "Multiple electric conductors or cables for telegraphic, telephonic and other purposes." B. J. B. MILLS. (Communicated by J. J. C. and M. Smith.) Dated June 1. (*Complete.*)

7329. "Automatic telegraphic apparatus or devices." J. H. JOHNSON. (Communicated by E. J. Mallett.) Dated June 1. *Complete.*)

7342. "Amalgam for voltaic electric elements." R. H. COURTENAY. Dated June 1.

7353. "Galvanic batteries." P. R. DE FAUCHEUX D'HUMY. Dated June 1.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

3941. "Dynamo-electric machines." J. SWINBURNE. Dated March 27. 8d. According to the invention, a dynamo has its poles arranged as in the well-known Hefner Alteneck or Ferranti alternating current machines, but the armature and commutator are so arranged as to give direct currents. The machine may have any convenient even number of pairs of poles. If it has two pairs of poles, it may have three or five coils. One set of ends of the coils are joined together and the other ends are led to three or five segments forming the commutator. Two brushes collect at opposite sides, and these brushes are broad enough to bridge well over the insulation between the segments. By this means generally two of the three coils are working in series and the third is idle, but while the brush touches two segments two coils are in parallel with each other, and together in series with the other. The brushes may be made broad enough, or the commutator segments may be cut obliquely to prolong this. Five coils work similarly.

7510. "Improvements in the continuous manufacture of light metals by application of electrolysis and in apparatus therefor." P. JENSEN. (Communicated from abroad by J. Omholt, of Norway, and the Chemische Fabrik Gössnitz, Böttiger and Seidler, of Germany.) Dated June 19. 8d. Consists of a suitable arrangement of a number of half retorts or bottomless retorts placed horizontally in a furnace or muffle, further by a suitable combination of these retorts with suitable receivers, as well as by leading away the light metals formed in the retorts in a melted or gaseous state in the receivers without interrupting the action of the electric current. The metals collected in the receivers are from time to time taken out in a heated condition and are allowed to cool, the air being excluded.

7733. "Improvements in electrical batteries." H. C. B. SHALDERS and A. J. THORMAN. Dated June 25. 4d. Consists of copper and zinc plates placed in damp sea-weed.

13,036. "Improvements in the manufacture of carbons for incandescent lamps." A. Bernstein. Dated October 29. 8d. Consists in making a carbon filament entirely out of hard and dense carbon, which is obtained by the decomposition of a liquid or gaseous carbon compound, and without any filament to deposit on. In order to accomplish this the inventor uses a vessel containing a carbon compound, which is decomposible by heat, and which compound may be in the form of a liquid or vapour. On the bottom of the vessel he places a conductor, say a piece of copper, which is connected with the negative pole of a suitable

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current generator. Then he suspends a wire, which is connected with the positive pole of the generator, in such a way that it may be made to touch the copper, and can be gradually and slowly withdrawn from it by suitable mechanism. As soon as the wire is withdrawn from the copper an arc is formed between them, and as the greatest heat is at the end of the wire which forms the positive pole, a deposit of carbon takes place at the end of the wire. The deposit so formed shortens the arc, but if the wire is withdrawn at the same rate at which the deposit is formed the result will be that a filament is gradually formed at the end of the wire, which filament consists entirely of a hard and dense carbon. The filament may be of any length, and the thickness of it can be varied by the varying speed given to the motion of the wire.

1886.

932. "Improvements in dynamo-electric machines, and in the transmission of power thereto." A. LE NEVE FOSTER and F. V. ANDERSEN. Dated January 21. 11d. The objects of the invention for improvements in dynamo-electric machines, and in the transmission of power thereto, are as follows :—1. To provide more efficient means for securing or mounting an annular armature on its shaft. 2. To arrange, or construct, the bearings for the armature shaft in such a manner that the said bearings, together with the armature, commutator, and brushes, can be withdrawn from the bed plate without affecting the other parts of the machine. 3. To provide efficient means for varying the positions of the brushes employed to collect the current from the commutator of a dynamo-electric generator, so that the lead can readily be adjusted. 4. To provide means whereby the position of the whole machine may be adjusted without interfering with its foundation, so as to allow the belting by which the machine is driven to be readily tightened as may be required. 5. To provide means whereby the direction of rotation of the armature will be constant, even if the direction of rotation of the prime mover is reversed, and thus dispense with the ordinary mechanism and double set of brushes by which the lead is adjusted, and the current maintained in a constant direction on the reversal of the armature shaft.

2002. "An improved method of applying electricity to the scalp or head for curative and other purposes." G. LICHTENFELD. Dated February 11. 4d. Consists, essentially, in adapting to wigs, part wigs, head-dresses generally, caps, hats, bonnets, and other descriptions of head-gear, or coverings for the hair and head, of any suitable constant battery, by means of which a continual or constant current of electricity can be obtained and applied to the scalp or head, or any part thereof, as desired.

CORRESPONDENCE.

Central Station Lighting.

My attention has been called to a report which recently appeared in the *Times* of the inspection of a new installation of electric lighting at Paddington. The report states that this installation is "the first practical example of electric lighting from a central station by a direct current."

In common justice to a body of gentlemen who have subscribed capital and thrown their energies gratuitously into the establishment and working of a central lighting station at Eastbourne for the past four years, I am assured you will permit me to contradict this statement.

The Eastbourne Electric Light Company was incorporated in February, 1882, for the purpose of supplying electric light from a central station ; and by September of that year the company had laid over 8,000 yards of cable and commenced lighting. The Grand Parade, several of the more important streets of Eastbourne, and a number of shops and hotels were supplied with arc lamps.

The question of incandescent lighting was carefully considered, and within a few months from starting the directors were enabled to supply this light, and it is now largely used both for business and domestic purposes. The company have also secured the lighting of St. Saviour's Church.

That the consumers are well satisfied with the company's exertions is best shown by the fact that the circuit has just been extended by 4,000 yards to meet the increased demand for the light.

Eastbourne may therefore fairly claim to be the pioneer of electric lighting in its commercial aspect, and this credit it ought to enjoy.

Henry Turner,
Secretary Eastbourne Electric Light Co., Ltd.

May 28th, 1886.

[We do not expect to see aught but blundering when the *Times* takes in hand anything electrical. The recent notice in that journal of the Langdon-Davies "phonophore" is an example of newspaper science.—EDS. ELEC. REV.]

Long Distance Telephony.

On reading the paper on "Long Distance Telephony," by Mr. W. H. Preece, I was rather astonished by one or two startling assertions he makes. Speaking of noises on wires from external sources, he says, "It was quite easy to eliminate the effect of external disturbances by the use of a twisted metallic loop." Doubtless it seems very easy in theory, but is not so in practice, especially on long lines, which I understand Mr. Preece refers to.

Apparently it was not so easy in the case he mentions just before, where on a line from Regent's Park to the General Post Office (distance four miles) telephonic communication could never be carried on. By the way, this does not say much for the Post Office lines. Is this one of the improvements in working effected by them ? I have enquired, but cannot find anybody who has heard of the said improvements. Where are they ? What are they ? Perhaps in the systematical arrangement at Newcastle. There must be some error in the description of this arrangement, as no sense can be made of "Double wires were in use everywhere, and the telephone instruments were joined to the wires in parallel. By this arrangement, and having the call indicators of rather large dimensions the telephonic currents could not pass through the indicator owing to the magnetic inertia, but could only pass through the telephone whose indicator was cut out of circuit." Can a single instrument be joined up any other way except in parallel ? What have "rather large indicators" got to do with "magnetic inertia" ? and if a current owing to the "inertia" cannot pass through the indicator, of what use is the indicator ? Perhaps this is the reason that the long-suffering subscribers in Newcastle ring for 20 minutes or half an hour without an answer, and they have to send a boy round to get put through. From North Shields to Sunderland is only about eight miles (direct), but notwithstanding the admirable arrangement of the Post Office system, it is impossible to carry on conversation between the towns. Want of space forbids my entering into further details, but I certainly disagree with Mr. Preece's statement that the Post Office engineers have effected the "only improvements in telephone working."

A. Watts.

May 26th, 1886.

I have read the reports of Mr. Preece's paper before the Society of Telegraph Engineers, with some surprise.

It certainly seems a little strange to me, considering the wonderful perfection of the Post Office as laid down by Mr. Preece, that they have not got more subscribers, and also that in those towns where they have opened exchanges—with the exception of Newcastle—they have I believe been beaten by the private companies. Mr. Preece holds up the system of Newcastle as an example of perfection in telephony, but if the Post Office are so proud of their arrangements, it seems strange that they will not allow anyone with a knowledge of telephony to see their apparatus, while Mr. Preece has, I believe, visited many of the principal exchanges of the private companies.

I should like to know what improvements have been made by the postal telegraph engineers in telephony, because, though I have had considerable experience of this work, I cannot at present think of any. I agree with the remarks of Mr. Preece that the telephone has been

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stifled by a "grasping monopoly." Perhaps when Mr. Preece made this remark he was thinking of Newcastle, where a private company opened an exchange and obtained considerably over 100 subscribers. The Post Office authorities compelled the company to close their exchange and then canvassed the town, the company's exchange being closed for about 12 months.

This, I think, is a fair example of a "grasping monopoly." But this is not all; the Post Office finding that they could not stop the private companies, have seriously interfered with their establishing that trunk communication between towns of which Mr. Preece seems to think so highly.

This, no doubt, has resulted in delay, but the opposition of the private company to this "grasping monopoly" will probably yet be found inconvenient.

Slabee.

In looking over the report of the meeting of the Society of Telegraph-Engineers and Electricians in your issue of May 21st, 1886, I was very much struck by one or two remarks made by Mr. Preece, who says that no improvements have been made on the Bell telephone; if this is so, how does it happen that the Post Office prefer using the Gower-Bell, if the Bell is a superior instrument; and surely the Blake transmitter is allowed to be a vast improvement, for commercial purposes, on the Edison?

Again, Mr. Preece states that in no country has the telephone been so fully developed and systematically arranged as at Newcastle. This is saying a great deal, and I am of opinion that on inspection it would be found that the exchanges established by private companies, both in London and the provinces, are equally well, if not better, arranged than at Newcastle.

Then, as to improvements in telephone working having been made by the Post Office staff, I think the greater praise is due in this respect to the metropolitan and provincial companies, where, indeed, telephone working has greatly improved during the last year or so.

Telephonist.

May 25th, 1886.

[It would save a great deal of trouble if our correspondents would be more careful to read correctly the reports of meetings, or, if they attend the latter, to be careful not to misunderstand plain statements; there may no doubt be much to which exception may be taken in the conduct of the Postal system, but people should look before they leap and avoid incorrect and illogical statements. First with reference to the letter of our first correspondent. The elimination of external disturbances by the use of a twisted metallic loop is an accomplished fact and not merely a theoretical idea. The lines on this principle erected between London and Brighton, and between London and Liverpool, are both practically free from external disturbance, and on some sections where extra care has been taken in symmetrically arranging the wires there is absolute silence. As regards the wire between Regent's Park and the Post Office, this circuit, which is single and not double, has been placed at the disposal of inventors who have asserted, and have been desirous of proving, that their apparatus would eliminate inductive disturbances on a *single* wire telephonic circuit. With respect to the question of the improvements effected, the fact that a particular individual has never heard of a certain Mr. Smith is a not uncommon but hardly a conclusive argument in proof of the non-existence of that gentleman; besides, it is not usually the case that a trading company publishes to the world all the details of its working arrangements or states publicly the methods by which it is enabled to carry out its work efficiently. As to the criticism of the description of the Newcastle method of working, we may remark there is no error in the description of the arrangement; we are sorry that our correspondent is so far behind the time as not to know what "magnetic inertia" is or that the latter is in proportion to the mass of iron in a magnet; we are also surprised that he does not know that a telephone indicator is actuated by a battery and not by a telephonic current. It is quite possible that in one or two instances, owing to "faults" (and what system, however near perfection, is not liable to faults), a subscriber may have been temporarily inconvenienced, but that such failures continually occur, as our correspondent implies, is not correct. As to the impossibility of communicating between North Shields and Sunderland, not only is this statement absolutely untrue, but daily communication is also carried on through the 8 miles of wire in question with an additional length of 32 miles or 40 miles in all, *i.e.*, between Newcastle and Middlesborough. We believe that if application is made in the proper way every facility would be given to an applicant to see the postal telephonic apparatus. One reason why the Post Office have not got more subscribers is, that their rental charges are higher than those of the companies, a consequence of the greater perfection of their system involving heavier maintenance expenses. Coming now to the action of the postal authorities in regard to the company's exchange at Newcastle, we believe that this exchange was in the first instance started without the license of and in defiance of the Postmaster-General, a fact which our correspondent avoids mentioning; there are also other facts in connection with the case which if known would put a very different complexion on the matter. Lastly, we come to our correspondent "Telephonist." Mr. Preece did not state that the Bell was a superior instrument to any other, what he did say was that no instrument was superior to the Bell, *i.e.*, that there might be some as good but none better; moreover, Mr. Preece distinctly stated that the Post Office were only enabled to carry out their telephonic system owing to the fact that they had secured the right to use 20,000 Gower-Bell instruments; we believe that at the present time they could not employ any other form except by the permission of the holders of the Bell telephone patents. The mere expression of "opinion" that the Newcastle exchange would prove "on inspection" to be inferior to others, it is needless to say, goes for nothing, in the absence of proof. We, "who know," hold a different opinion. Coming now to the last paragraph of "Telephonist's" letter, we would refer him to a recent number of *Punch*, in which a description is given of the working of a telephone exchange system in a certain large town.—EDS. ELEC. REV.]

The Bell Telephone in America.

I hasten to send to the REVIEW a synopsis of the answer filed by the Bell Telephone Company to the suit brought by the United States. This synopsis was published this morning in a newspaper which obtains information from *head-quarters*, and is generally to be relied on. I have not had time to examine carefully for legal decisions which may have a bearing on this case; but I am clearly of opinion that the Court in Ohio will not sustain the demurrer, but will decide that when a corporation is doing business on a patent right, which the U.S. Government alone can grant, a suit can be brought by the U.S. Government in any district where such corporation is doing business.

The more I have examined the Bill and exhibits filed by the Government against the Bell Company, the more I am convinced that the prosecution will fail to establish fraud in obtaining the patent; and I still hold the opinion I expressed in my letter published in the REVIEW of March 12th, that the Government, in the absence of any statute, can bring a suit to annul a patent for *fraud only*.

The fraud alleged in the Bill is that the caveat of Gray was filed in the Patent Office *before* Bell's application for a patent was filed, and that Bell or his agents fraudulently obtained from the files information as to what were the principal features in Gray's caveat.

From the records of the Patent Office it is esta-

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blished: 1st. That both applications were filed on the same day—14th February, 1876. 2nd. That Bell's application was filed before Gray's caveat. The part of Gray's caveat put into Bell's specification as amendments on 29th February, 1876, is concerning the "*undulatory*" current; that sort of current is named in Bell's original specifications, and the claims granted in his patent are word for word the same as those originally filed on 15th February, 1876.

Should this suit ever be tried I am of opinion that the only question which the Court will hear is that of "*fraud*," and the result will be that no fraud can be proved.

I have, after several years' research, found the original publication containing a full account of Bourseul's telephone, written by himself, and published in 1854, and I shall send you shortly a correct translation of it.

W. C. Barney.

McPherson House, Washington,
May 18th, 1886.

The Incandescent Lamp Patent Case.—Second Action.

In the absence of all verbal evidence on behalf of the defendants in the above case, Mr. Justice Butt could scarcely avoid following the weight of scientific evidence given by the witnesses for the plaintiff company, although it appears he noticed some discrepancies in one part or the other of their examination.

Presuming the admitted publication of Despretz's discovery would waive all legal difficulties as to the utilisation thereof by the public at large, the practical points alone remain and on these the learned judge based his judgment; these appear to be three in number, viz.:—

1. Sir Frederick Bramwell, he says, showed in substance that uniformity of heat produces uniformity of deposit per unit of area, and that is just what you do not want in forming a carbon conductor as described by Cheesbrough.

2. That Prof. Dewar intended to abide by this, that one could not cure the porosity of carbons without the gradual increase of current.

3. That Dr. Hopkinson says, Despretz's publication on "Volatilisation of Carbon" would be more likely to deter, than to invite an inventor of incandescent lamps to look into it.

On each of the above statements an experienced operator in the process of flashing—the technical name now used for the electro- or thermo-deposition of carbon on other carbon—in his evidence would, I think, have made such comments as materially to have influenced the final opinion of the judge and possibly altered his verdict.

In answer to No. 1, while agreeing that "uniformity of heat produces uniformity of deposit per unit of area" is a recognised scientific law, he would qualify the assent with respect to the case in point, for here to obtain a uniformity of heat to uniformity of area, it would be practically impossible unless the *sectional area* of the filament was similar throughout its length; and then an even temperature would be exactly the desideratum by producing an equal deposit. When a filament is of a varying section, the intensity of heat will vary as the section and so will the deposition, thus *automatically* bringing the carbon to a proper thickness and regular density.

In reply to No. 2, "That without a gradual increase of current the porosity of a carbon could not be cured," he would say, The best results in closing the pores and building up a carbon are attained by the use of the highest temperature consistent with the physical cohesion of the filament; and the ampère current to produce this will vary with the section and the density of its substance. As an instance that the highest temperature is essential, it sometimes happens that the electromotive force available is not sufficient to raise the temperature rapidly; the deposit suffers in quality, frequently producing a roughness on the surface of the filament, like unto small trees. This fact shows that a proportionally high current is required at all stages of the flashing process. If, however, instead of ampère current the power employed or energy is taken in watts, then, in place of increase of current the converse ensues, the watts safely absorbed being a constantly diminishing quantity, the E.M.F. falling and ampères rising, the latter varying with the section and density of the filament, and apparatus has to be fitted up to specially allow for this. But in the Despretz experiments where a carbon of considerable bulk was used, which would stand all the available current, the deposition would lower the resistance, thus raising the ampère current *automatically*, and unavoidably unless special precautions were taken to lower the E.M.F. in a like manner when flashing thin pencils or filaments.

In regard to No. 3, Dr. Hopkinson's statement is simply a matter of opinion, and in opposition to him a practical inventor with any experience of incandescent lamp manufacture, would, for more reasons than one, seize with avidity a paper with the title "Volatilisation of Carbon," which might present to him the cause of blackening bulbs and perhaps lead to the means of avoiding this fault.

Practical evidence would thus have tended to show that the effects resulting from certain processes, published over 30 years ago, automatic in their action and part and parcel of the operations as a natural physical result, would, though undescribed, appertain to the manufacture and therefore could not be entitled to be considered a proper subject for separate letters patent for a process precisely similar to Despretz's. If it were not generally known to the contrary, the absence of witnesses on behalf of the defendants might give rise to the idea that the action was arranged in some manner to the mutual advantage of both parties.

Ram.

Schanschieff's Battery.

Will you kindly allow me to reply to the letter of Mr. Edward Conry in your last issue. Mr. Conry says he has tried my battery. I have written him asking him from whom he obtained my solution, to which he has not replied. I think I am justified in concluding from the text of his letter that he has never tested *my* battery, but has simply tried some of my solution with elements from a bichromate cell. He says the E.M.F. is not greater than in the old bicromate. I have never claimed that it is. He says the battery has an unpleasant habit. My battery has no habits, pleasant or unpleasant, nor has it any crystalline deposit on the zincs. The deposit on Mr. Conry's zincs "reminds him of green chromate;" doubtless it does. It is evidently crystals of chrome alum displaced from his porous carbons by my exciting solution.

It is a question which is continually being put to me whether my solution can be used with elements from a bichromate battery, and I have as often to caution enquirers that the work of the solution would be utterly spoilt.

There is no necessity to squeeze the deposit in the cells through washleather. I purchase the deposit as it is at 1s. 4d. per oz., equal to 2s. 2d. to 2s. 6d. per gallon, according to the degree to which the liquid is worked out.

Mr. Conry thinks my battery is not as good as one or two single liquid batteries we have already.

Fortunately his opinion does not influence facts.

I challenge Mr. Conry to produce any other single liquid battery of equal size which will give *only* six hours continuous work.

I can positively assert that Mr. Conry never applied to me for nor received direct from me (sole manufacturer of Schanschieff's Batteries and Solution) either battery or solution. If he will apply he will certainly receive every facility to make a proper test.

A. Schanschieff.

June 1st, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 446.

DYNAMO ENGINES.

VISITORS to the Colonies Exhibition will have noted the disappearance from the electric light shed of the high speed engines which last year figured so conspicuously in driving the dynamos. Amongst those we remember to have seen driving machines direct were the Coalbrookdale engines attached to the Gülcher dynamos, the Willans to Crompton's machine, the Chandler to Siemens, the Tower to Elwell-Parker, and for the lighting of the gardens the compound engines of Goodfellow and Matthews attached to the large Siemens machines. Of these the last named alone remain and they are kept by the contractors as spare plant to be used only in the case of an emergency.

Although some of the engines mentioned behaved well during the Exhibition, others did not, and those of our readers who were frequent visitors will remember how often the cylinder or slide jacket covers were removed and daylight thus allowed to penetrate into those so-called *closed* engines. They will also be prone to compare the smooth working of the Paxman and Galloway engines now employed with the rapid and feverish performance of some of those which occupied their place a year ago.

Unfortunately, engineers are divided in their opinion as regards high and low speed engines. Some declare against the use of high-speed engines under any circumstances, while others as emphatically pronounce in their favour and fail to discern in them any defect whatever. The truth is, that the choice of an engine like the choice of most other things must depend upon circumstances; while one class of engine might serve our turn under one set of conditions, under another set it might be quite unsuited for our purpose. That quick-running engines have worked in many cases most successfully is an undoubted fact, and it is our belief that the bulk of the failures which have occurred are to be attributed simply to engineering defects and to ignorance of the principles which should guide the designer in constructing engines of this class.

Durability and economy of fuel are amongst the most important questions relating to this subject. As regards the former it is certain that with good proportion, efficient lubrication, and careful adjustment of the wearing surfaces to the strains to which they are subjected, high-speed engines can be made durable; but at the same time we think there is a limit to the speed which must soon be reached, more particularly in the case of the larger sizes where the reciprocating parts are necessarily heavy. Mr. Arthur Rigg in his paper read before the Society of Engineers, remarks that of late an opinion seems to have grown that because small high-speed engines are run with satisfactory results at speeds exceeding 200 revolutions per minute, therefore the same engines may be driven far faster with equal success; an opinion which has been partly fostered by the requirements of electrical engineers and which has led to a series of disasters of a character most discreditable to our national reputation for engineering skill. Mr. Rigg proceeds to specify the conditions which ought to be observed in designing high-speed engines, and gives diagrams and particulars of several engines which he has designed and which have been working successfully for some time. In the Allen engine introduced into this country some years since, the speed was maintained continuously at 200 revolutions per minute, the piston having a 24 inch stroke and an average velocity therefore of 800 feet per minute. This engine worked quietly and without pounding, the whole secret of its successful performance lying in the balancing and in the careful adjustment of lead and compression to the weight of the engine's reciprocating parts.

It is of the utmost importance in quick-running engines that the cushioning of the steam be such as to bring the piston gradually to rest at the end of the stroke without straining the crank pin, and a simple calculation enables the engineer to determine approximately the pressure to which for any speed and weight of reciprocating parts the steam should be compressed. Taking the Allen engine with its stroke of 24 inches and its reciprocating parts weighing 470 lbs., that there may be no strain on the crank pin, when the piston arrives at the end of its stroke it must experience a resistance to motion of nearly 6,400 lbs. which, taking the area of the cylinder at 113 inches, corresponds to a steam pressure of about 57 lbs. per square inch. Unless the entering steam is above this pressure the piston will be dragged on by the crank pin, and not until it has completed part of its stroke will its forward motion be due to an excess force on the steam side of the piston. The liability to knocking in high-speed engines with light loads is well known, and it is satisfactory to know that it can be cured by careful attention to the points to which we have referred. The reciprocating parts ought to be as light as possible, the compression ought to be independent of the load, and the engine should never be throttled, the steam supply being adjusted to the requirements of load by an early or late cut-off. These conditions are more or less perfectly fulfilled in the best high-speed engines, lightness of reciprocating parts being secured in some types by making the pistons, connecting rods and valve spindles hollow.

It may be mentioned that our ideas of engine speed are liable to some confusion from the fact of our talking of piston speed rather than of the number of reciprocations per minute. In all cases the piston speed increases with the size of the engine, although the number of revolutions diminishes, and it is the latter which is of importance in this consideration. Thus the Westinghouse engine indicating 2 horse-power makes 600 revolutions with a piston

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speed of 300 feet per minute, while that indicating 130 horse-power makes 275 revolutions with a piston speed of 687 feet. Willans' engine, indicating 3 horse-power and running at 900 revolutions, has a piston speed of 450 feet, while the 100 horse-power engine runs at 400 revolutions with a piston speed of 600 feet. Both these engines are single acting, but the same remarks apply to double acting engines of the "Invincible," "Allen" or other reciprocating high-speed type.

Before comparing the merits of single-acting and double-acting engines, we would refer to a matter of some importance as regards the driving of dynamos direct. Our readers are aware that in every reciprocating engine the power is delivered to the shaft in the form of intermittent pulsations, and when driving dynamos direct the power is of course transmitted in this form to the armature of the machine. In belt driving the power is delivered to the dynamo spindle with much less variation, due doubtless to the irregularities being taken up by the elasticity of the belt and by any slip which may occur. Armatures, which until lately, were regarded as models of mechanical stability, have in several instances hopelessly broken down when direct driving has been employed, and we cannot too strongly advise the use of a flywheel placed between the dynamo and the engine whenever the two are coupled together. The flywheel does not alter the form in which the power is delivered to the crankshaft, but it reduces greatly the periodic strains on the armature supports and substitutes instead of those an intermittent twist on the shaft between the cranks and the flywheel. It is probable that transmitting the power to the dynamo through a flexible or spring coupling as in the case of gas engines would prevent the destruction of the armature, but if we have in the engines a turning moment which is approximately constant during the whole of the revolution, the necessity for this contrivance is of course avoided. By a careful adjustment of the weight of the reciprocating parts to the speed, load, and grade of expansion, this approximate uniformity can be secured.

The same precautions as regards cushioning must be adopted in both single and double acting engines, and it appears that in the working of these two classes there is little to choose between them. In all high-speed engines the strains of a dynamic character depending upon the motion of the different parts are of immense importance, and the rotatory and reciprocating masses ought to be balanced as perfectly as possible. With this end in view the cranks in twin-cylinder double-acting engines are placed opposite each other, but it is necessary notwithstanding that each piston shall have the compression properly adjusted to its speed and weight. If this point is overlooked, it is just possible that the twin-engine might be, owing to the surging of the two heavy weights at opposite angles, more out of balance than a single engine. The cylinders ought to be kept as close together as possible in these engines in order to reduce the moment of this deleterious couple. Single-acting engines are heavier for a given amount of work than those which are double-acting, and the latter have the additional advantage of impelling the piston in both directions with a single cylinder, while to get a motion as uniform from a single-acting engine two cylinders must be employed. With large wearing surfaces the double-acting engine will doubtless run for long periods without any readjustment of the connecting rod brasses, but the single-acting engine has the advantage of the wear being taken up by the engine itself, its rods being always in compression. From the fact of trunk pistons being employed, it is possible to get a longer connecting rod in the latter for the same head room, but on the whole we think the two classes are about equal in merit everything considered.

We have said that high-speed engines can be made durable, but durability is after all a question of degree. We do not think for a moment that engines running at great speed can be compared in point of durability with slow-speed engines, and any data that would alter our conviction, if it exists, is very difficult to get hold of. We have a rooted antipathy to anything over six hundred revolutions per minute in engines, and our ideas are such as prompt us to advise slower speed engines, and belt or rope driving in every case where what we believe to be the only important advantage of direct driving, namely, compactness, is not a desideratum. With high speed the wear is certainly greater than with low speed, and to imperfectly neutralised dynamic strains combined with high velocity this must be attributed. In slow-speed engines like those at the present Exhibition, these dynamic strains are unimportant, accurate balancing is not necessary, and some approximation, sufficiently near the mark for practical working, is found in loading the crank disc, or in putting the cranks at opposite angles. The Paxman coupled engines at the Exhibition have a cylinder diameter of 18½ inches with a stroke of 32 inches and run at 72 revolutions per minute; the Galloway compound engines have cylinders of 15 and 26 inches and run at 100 revs. with a stroke of 30 inches. The former corresponds to a piston speed of 384 feet per minute, the latter to 500 feet.

It is to be regretted that information regarding fuel and water consumption in high speed engines is so difficult to obtain; it is still more to be regretted that some, having in view the excessive consumption of one or two particular types, brand all alike with the opprobrious epithet of "steam eater." Although in high speed engines generally, for some reason or other, the consumption of water and coal has not been reduced to the amount required for slow-speed engines, yet very satisfactory results have been obtained from time to time with some of them. We are not prepared to place much confidence in the accuracy of indicator diagrams taken from high speed engines; we much prefer tests with an absorption dynamometer, and we trust that when comparative tests are to be made this method of comparison will be adopted. From tests made with the Westinghouse engine we find that the steam used was 34·36 lbs. per I.H.P. per hour, or 38·8 lbs. per brake H.P., the coal used being 5 lbs. per I.H.P. per hour. In the tests of the Willans compound engine to which we referred a short time ago, the steam used per I.H.P. per hour was 23·2 lbs., a very satisfactory result when compared with those obtained from slower running engines. With an evaporation of 9 lbs. of water this is equal to a consumption of 2·6 lbs. of coal per I.H.P. The compound triplex engine, by Goodfellow and Matthews, is said to consume from 2·5 to 3 lbs. of coal, but whether in these cases the same results would be obtained from runs extending over a long period we are unable to say. The Paxman engines at the Exhibition show in the compound non-condensing class a consumption of fuel of from 2·2 to 2·3 lbs. per I.H.P., the steam used being from 21 to 22 lbs., and this result extends over a long period. In the compound condensing class the consumption of fuel is under 2 lbs., and the steam is reduced to 18 lbs. Both these classes have a boiler pressure of 115 lbs. per square inch. In the non-compound non-condensing class the pressure is 95 lbs. per square inch with a cut off at ⅝ths stroke, and the consumption of fuel is 4⅓ lbs. per I.H.P., the steam used being 42 lbs. The evaporative power of the steel loco-type boilers is equal to 9 lbs. of water per lb. of Welsh coal at 20s. per ton, and our readers from this will be able to see how much they have to pay for each watt appearing in the lamp circuit when the dynamo gives 70 per cent. of the I.H.P. of the engine. In conclusion we may state that these engines are worked with the steam valve full open, the grade of expansion being regulated by the governor in conjunction with automatic slide gear. We are assured by Mr. Paxman that when the load is suddenly and completely removed the increase of speed is not more than 2 per cent., and we hope to have a chance of verifying most of the above data for ourselves shortly.

Postal and Telegraph Reform.—At the forthcoming conference in connection with the Colonial and Indian Exhibition, "Postal and Telegraph Reform" is amongst the topics set down for discussion.

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THE INCANDESCENT LAMP PATENT CASE.

WE have now reported in these columns much of the evidence and the judgments on two of the most important trials which have ever taken place with regard to the subject of electric lighting.

Taking into account the difficulty of the questions involved, and the magnitude of the interests at stake, we believe that we shall be doing a service to our readers if we endeavour to analyse these judgments; not pronouncing a definite opinion upon them, but rather endeavouring to determine clearly what has been decided, and what effect the decisions will have on the manufacture of electric lamps in the future.

The actions were brought by the amalgamated companies owning the Edison and Swan patents against Messrs. Woodhouse and Rawson, the well-known makers of incandescent lamps.

In the first action three patents were sued upon, viz.: 4,576, of November 10th, 1879 (Edison); 18, January 2nd, 1880 (Swan); and 4,193, of September 29th, 1881 (Gimingham).

With regard to the second of these, it may be briefly described as a patent for the operation of "running on the pumps," as applied to carbon lamps. This, there is no doubt, would have been held void for want of novelty, had the matter been pressed to a decision; but in the course of the case the counsel for the plaintiffs really failed to bring any evidence that such a process had been used by the defendants. This seems to have been in reality no oversight, for by this means a decision on the patent was avoided. Had the validity of the patent come in question, it would in all probability have been upset, on the ground that in a previous patent of Edison's, June 17th, 1879, No. 2,402, the very same process is described for the removal of the occluded gases in metal filaments, with the intimation that "carbon sticks may also be freed from air in this manner." Quite apart, therefore, from any other anticipations, the above-mentioned patent of Edison seems to disprove the novelty of Swan's patent. It may, perhaps, be a matter of wonder that (Edison owning the patent) the plaintiffs did not sue upon it. But the patent itself was weak for other reasons, and, moreover, only claimed running on the pumps as applied to metal filaments. It was, therefore, clearly useless as a weapon of offence, and only served to destroy Swan.

Gimingham's patent consisted in the flattening out of the platinum leading wires, and drawing them through a plate so as to make a socket, similar to that which holds the lead in pocket pencils. This also would probably have been held invalid for want of novelty; but here, also, the evidence of infringement given by the plaintiffs was of so shadowy a character that by their own consent the patent was not pushed, and a verdict thereon, as well as for the patent of Swan, passed for the defendants.

On the other hand, the patent of Edison was upheld, and the decision is so interesting that it is well worth a careful analysis.

The patent substantially is as follows:—"It is essential that lamps should be of great resistance . . . . In patent, 1879, 2,402, I have set this forth and obtained lamps of great resistance by employing long lengths of platinum wire. . . . . My present invention relates to lamps of a similar character, except that carbon threads or strips are used instead of metallic wires. . . . . Heretofore, light by incandescence has been obtained from rods of carbon of one to four ohms resistance, placed in closed vessels in which the atmospheric air has been replaced by gases that do not combine chemically with the carbon . . . . the connection between the leading wires and the carbon has been obtained by clamping the carbon to the metal. The leading wires have always been so large that their resistance shall be many times less than the burner, and, in general, the attempts of previous persons had been to reduce the resistance of the carbon rod. The disadvantage of following this practice is that a lamp having but one to four ohms resistance cannot be worked in great numbers in multiple arc without the employment of main conductors of enormous dimensions, that owing to the low resistance of the lamp the leading wires cannot be of large dimensions and good conductors, and a glass globe cannot be kept tight at the place where the wires are passed in and cemented, hence the carbon is consumed because there must be almost a perfect vacuum to render the carbon stable, especially when such carbon is small in mass and high in electrical resistance. . . . . I have reversed this practice; I have discovered that even a cotton thread, properly carbonised and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures. But if the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating within a closed chamber be so coiled, that as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than $\frac{3}{16}$th inch." The inventor then goes on to describe carbon filaments made of tar and lampblack kneaded and drawn out into threads, wound into spirals and carbonised, and to suggest the introduction of volatile powders into this filament to increase its resistance.

He then describes a method of uniting a filament to platinum wires, by moulding plastic lampblack and tar round the joints, and afterwards carbonising them, and goes on to say that cotton and linen thread, wood splints, paper coiled in various ways, and lampblack, plumbago, and carbon in various forms, and kneaded with tar, may be made into wires of uniform thickness. He describes a method of winding the spirals on copper to prevent distortion during carbonisation, and dissolving away the copper afterwards by means of acid.

He claims:—

First—An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described, and secured to metallic wires as set forth.

Second—The combination of a carbon filament within a receiver made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purposes set forth.

Third—A coiled carbon filament or strip arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light, as set forth.

Fourth—The method herein described of securing the platina contact wires to the carbon filament, and carbonising of the whole in a closed chamber substanstantially as set forth.

At the trial it was admitted that the defendants had made a certain lamp, one of those so well known that we need not describe it. It consisted of a thin thread of carbon fixed to platinum wires, sealed into an exhausted globe wholly of glass. As a matter of fact, its resistance was about 60 ohms; but this did not very clearly appear at the trial.

Every manner of objection was taken to the patent in the pleadings (as is usual), but substantially the defence was that as to the first claim, the defendants did not infringe it, for it was not shown that they made the filament "as described," or secured it "as set forth;" as to the second claim, that the combination thus described was old.

As to the third claim, that the coiled carbon filament was also old. The fourth claim was admitted not to be used by the defendants, but no evidence seems to have been offered that it was old.

In the evidence at the trial it was shown, as before said, that the defendants did not make their carbon filaments as described. On the contrary, that they made them by a private process of their own, which they declined to reveal. Therefore, in the absence of evidence that they were made "as described," on this point the judgment was that the first claim was not shown to have been infringed. As to the second claim, it was admitted that a lamp made by Swan, and consisting of a slender stick of carbon, about as big as the carbon of a lead pencil, and attached to platinum

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wires, and sealed in a globe consisting wholly of glass, had been publicly exhibited before the date of Edison's patent. It was further proved that Sidot had proposed the carbonisation of strips of wood, thread and silk, by means of heat, and had suggested their use for electric lighting, but whether for arc or incandescent use did not clearly appear. It was also proved and not disputed that carbon sticks and pencils had been long in use in vacuo for incandescent lighting (though this did not carry the case further than it was carried by Swan's anticipation), and it was also shown that two inventors, Pulvermacher and Van Choate, had proposed carbon spirals, one to make a sort of electric candle and the other for use for electric lighting, which appeared pretty clearly from his patent to be electric lighting of the "incandescent" order. On these grounds the defendants argued that the word "filament" had been nowhere clearly defined by Edison, that he had not shown where a "stick" ended and a "filament" began, that it was no new invention merely to put a thin Sidot "thread" in a "Swan" lamp, and that the previous anticipations by Pulvermacher and Van Choate of the third claim to carbon "spirals" vitiated the whole patent. Morever, it was shown that metallic spirals were in previous use, as also carbon sticks, pencils and rods, and it was argued that it was no new invention merely to make a carbon spiral. A vast mass of evidence was given on both sides, but on a perusal it will not be found to alter the facts above set forth.

Now it will be observed that Edison nowhere points out that his filament is elastic, but only that it is of high resistance and small sectional area.

The decision of the court was that the second claim to a filament enclosed in an exhausted receiver of glass was good, and that the defendants had infringed it. In order to decide this it was, of course, necessary for the judge to decide what a "filament" was, and this proved the real difficulty of the case. Finally, he decided that by a filament was meant a carbon conductor of small cross section possessing flexibility and resilience and of high resistance. He further added that he was inclined to the opinion that the resistance should be at least over 100 ohms, but did not consider it necessary to decide that point.

With regard to this decision it may be remarked that neither flexibility nor resilience are anywhere pointed out by Edison as necessary to his filament, and as to the last, if the Court of Appeal should coincide with Justice Butt's opinion, that a resistance of at least 100 ohms is necessary to constitute a "filament," then, in that case, they will have, in all probability, no alternative but to order a new trial, or else reverse his judgment, for if this resistance be a necessary part of the notion of a filament, then not only was no proof given that the infringing lamp had that resistance, but simple inspection of the lamp produced in court showed that it could not have a resistance of more than about 60 ohms. Moreover, it will still be necessary to do what Mr. Justice Butt has as yet not attempted, viz., to define the limits at which a filament begins.

Without discussing further the eventual chances of this case, it will appear clear to the electrician that it is not so difficult to make a lamp altogether outside this patent. For if once a lamp have a filament made in a manner different from that described by Edison, or else not "secured as set forth" it will avoid the first claim, and if it be enclosed in a receiver not made wholly of glass it will avoid the second, if it be not of a spiral form it will avoid the third, and if it be not "secured as set forth" it will avoid the fourth claim. It is, of course, very perilous to prophesy, but certainly, even if the Court of Appeal support Mr. Justice Butt's judgment by rejecting a portion of the reasoning on which he founded it, it is yet within the bounds of human probability that some inventor may yet devise a lamp consisting of a filament neither enclosed in a receiver "entirely of glass" nor "secured as set forth," in which case it is difficult apparently to see how he could be attacked by the Edison patents.

(*To be continued.*)

HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

VIII.—COMPOUND MACHINES (*concluded*).

THESE corrections will evidently be different in the two methods of winding. For the ordinary compound winding shown in fig. 3 (see ELECTRICAL REVIEW, May 28th), in which the shunt coils are attached to the poles of the armature, let *g*, *h*, fig. 6, represent the same line as *g*, *h*, in fig. 5. In the same way as before, determine approximately the current required for the shunt circuit and the loss of potential allowed for the series coils. Lay off *o*, *r*, equal to the shunt current (exaggerated in this diagram for the sake of clearness), then *r*, *s*, will represent the ampère turns required in order to supply the necessary current for the shunt when the machine gives the proper potential on an open circuit. The currents in the lamp circuit will, therefore, be measured from *r* to the right; that is, they are equal to the whole armature current, *o*, *i*, for instance, less that used in the shunt, *o*, *r*.

When the current flows through the lamps, and therefore through the series winding, the potential at the poles of the machine would fall by the amount which is absorbed by the series coils, for in the test the machine was run with constant potential at the armature. As this fall of potential increases with the current, it will have to be generated again by a corresponding increase in the number of series windings. Furthermore, as this fall of potential does not begin until the series coils begin to act, a line, *s*, *t*, drawn from, *s*, making a certain small angle with *s*, *h*, would represent the necessary increase of the ampère windings, in order to increase the potential at the armature, so that at the poles of the machine it may be constant. Furthermore, if the potential at the armature poles be increased, the current in the shunt will be increased, for it is connected with these poles. The question then arises how many of the ampère windings will then remain for the series coils to generate. This may be calculated as follows :—From the allowable loss of potential in the series coils at the maximum load, calculate by simple proportion what the total increased number of ampère turns must be ; in other words, if the constant potential, V, volts requires *h*, *i*, ampère windings, then V + *v* volts (*v* being this loss) will require $\frac{V + v}{V}$ (*h*, *i*) ampère windings. This gives the distance, *i*, *t*. Then *s*, *t*, will represent the true corrected curve which gives the true values of the ampère turns which will so raise the potential of the armature that the potential at the poles of the machine will remain constant.

The proportion of this which will have to be allotted to the series coils is obtained as follows :—Knowing the highest potential at the armature, V + *v*, and calculating the resistance, R, of the shunt coils from the potential on open circuit and the current in it, we are enabled to calculate what current will flow through it at the maximum load when the potential at the armature is V + *v*. This gives for the maximum current through the shunt $\frac{V + v}{R}$ which multiplied by the shunt windings give the ampère windings in the shunt for the full load. Therefore, if we lay this off at *i*, *d*, then it will leave *d*, *t*, ampère windings to be supplied by the series coils. Dividing this number of ampère windings, represented by *d*, *t*, by the current in the external circuit (remembering to subtract that in the shunt for *d*, *i*, ampère windings from the whole current, *o*, *i*) it will give the corrected number of windings for the series coils.

Having thus found the proper number of windings for the series coils, and having given its maximum current and its allowable resistance (from the fall of potential and maximum current), the rest of the calculation is the same as for series machines, except that in this case the series coils are limited to a much less

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space. In the same way, having found the maximum number of ampère windings, *i*, *d*, of the shunt coils, and having given its allowable current and the maximum potential at the armature for full load, the rest of the calculation is the same as that for ordinary shunt machines.

On account of the inflexibility of the thick wire, the series coils are generally wound first and the shunt coils over them. In that case care should be taken to correct the mean length of the shunt windings; for what was before the space occupied by the core for an ordinary shunt machine, is now that occupied by both the core and series winding. Another way to wind the magnets is to place the series coils at one end of each, or of alternate magnets. This is not advisable, as it requires more time and care to wind them, and they are likely to slip over one another unless held by a guard of some sort, which occupies valuable room in the coils.

The diagram also shows at a glance how the ampère windings are divided between the shunt and series coils. The line, *s*, *t*, fig. 6, gives the corrected relation between the armature current and the required ampère windings for constant potential at the poles of the machine. The space below the line, *s*, *d*, will show how much of the magnetism is supplied by the shunt coils, while the space between *s*, *d*, and *s*, *t*, shows how much is supplied by the series coils. The space, *s*, *r*, *o*, *g*, shows the proportion of the whole number of ampère windings required to generate the current for the shunt coils, and the space, *h*, *s*, *t*, that required to generate the potential lost in the series coils. If the current in the external circuit were *r*, *z*, for instance, it would be seen at a glance that the machine was running very uneconomically, as about half the energy generated is absorbed by the magnets.

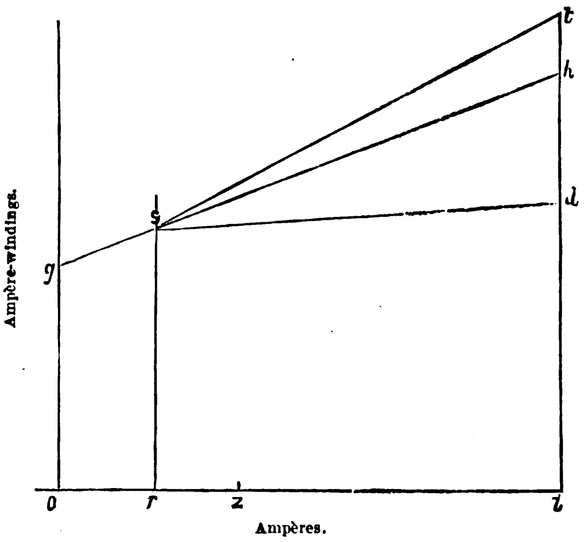

FIG. 6.

For the "long shunt" winding, in which the shunt coils are connected with the poles of the machine, as shown in fig. 4 (ELECTRICAL REVIEW, May 28th), the corrections will be somewhat different. Referring to fig. 7, let *g*, *h*, represent, as before, the results of the experiment, as in fig. 5. In the same way as before, determine approximately the loss of potential allowed for the series coils and the total number of ampère windings which will be required to generate the proper potential plus what is lost in the series coils. Lay this off as *t*, *i*, then *t*, *g*, will give the corrected values for the ampère windings required. As the whole current passes through the series coils in this case, it is evident that their action will be proportional to the armature current and not to the external circuit current, as with the ordinary compound winding. From this it follows that the ampère windings for the shunt magnets must be that represented by *g*, *o*, and as this is constant for any number of lamps, *g*, *d*, is in this case horizontal, leaving *d*, *t*, as the number of ampère turns to be supplied by the series coils at maximum load. Knowing the whole current (including shunt) at this load, the number of windings is the quotient of the two; that is, $\frac{d\,t}{o\,i}$. Having thus found the number of windings of the series coils, and having given its maximum current and its allowable resistance, the rest of the calculation is the same as before. In the same way, having found the ampère windings of the shunt coils, and having given its allowable current and the constant potential at the poles of the machine, the rest of the calculation is the same as before.

The diagram also shows, as before, that the space below *g*, *d*, represents the ampère windings in the shunt; that between *g*, *d* and *g*, *t*, represents the ampère windings in the series coils. The space, *g*, *e*, *r*, *o*, represents the ampère windings required to supply the shunt current, and *h*, *g*, *t*, that required to supply the energy lost in the series coils. The distance, *s*, *e*, represents the ampère windings generated by the series coils on open circuit; that is, when they act together with the shunt coils as such. It will be seen, by direct comparison of figs. 6 and 7, in what manner the proportions of the different coils will vary in the two different systems. In fig. 7, the shunt coils are evidently smaller, and the series coils larger.

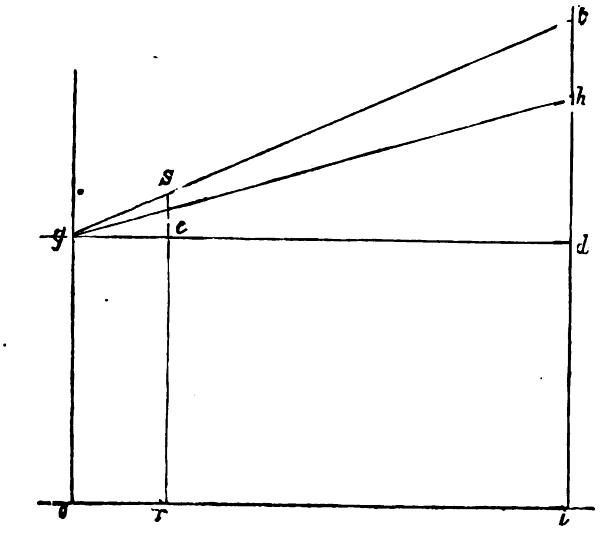

FIG. 7

In many systems of distribution for incandescent lamps, the potential at the lamps will fall with an increased number of lamps, owing to the increased current in the leads. If it is desired to correct for this in the winding of the machine magnets, it is only necessary to increase the number of series windings by the proper amount, in order to generate the desired increase of potential at the poles, which can readily be calculated. This correction is made in the same way as that for the loss of potential in the series winding. If this correction for leads is comparatively great, care should be taken to correct the shunt winding also, on account of the increased potential at its ends.

As will be seen from the above description, much greater care must be taken, and more accurate calculations must be made for compound machines than for ordinary shunt or series machines. A change in one quantity will affect several others; especially is this the case with the speed, which should be kept the same throughout; if it cannot be maintained constant, there is little use in attempting to make the machine more than a rough approximation to one of constant potential.

If, upon running the finished machine, it is found to give too low a potential, owing either to an error in calculation or to the copper having a higher resistance than was assumed, a change in the speed will correct

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the potential for that load; but the machine will then no longer have a constant potential, as a change in speed alters the required proportion between the series and shunt coils.

If it is desired to make final adjustments or to allow for slight errors in calculation, or for certain small changes of speed, the shunt coils may be so calculated as to have a somewhat smaller resistance than would otherwise be necessary, and then there may be included in its circuit an adjustable resistance; this will enable one to adjust the shunt coils. To adjust the series coils, they must be calculated for a somewhat smaller current than otherwise, and an adjustable resistance placed between the terminals of the series coils so as to shunt off a portion of the current. By this means both series and shunt coils can be adjusted or varied between certain limits, thus avoiding the necessity of great accuracy in calculation. This also allows for the correction of small unavoidable errors, and for adjustment for a slightly different speed. These adjustable resistances, after being set by experiment to their proper values, need no further alteration. From the different functions of the two coils it can readily be seen which of them requires to be varied in adjusting the machine.

In conclusion, let us examine the diagram, fig. 5 (ELECTRICAL REVIEW, June 4th) again, in order to see what are the best proportions for a good compound machine. As the curve of magnetisation, *a*, *c*, should be as straight as possible, the magnets should be of as soft a quality of iron as possible, and should just begin to be saturated with the maximum load. They should, therefore, be large enough, and there should be no great resistance to the lines of magnetic force by a scant allowance of iron at any part of their circuit. The magnets and iron should, of course, be arranged as economically as possible as regards utilisation of the field.

As the armature resistance increases, the angle which the line, *g*, *h*, makes with the horizontal increases, and hence, also, the number of series coils; in this case the deviation of the curved line, *g*, *h*, obtained from experiment and the straight line assumed, becomes greater, as also does the deviation of the finished machine from a constant potential one. From this it is seen that it is desirable to have the armature resistance as low as practicable, and, therefore, the field more intense, up to a certain limit. A Weston machine, exhibited at the Philadelphia Electrical Exhibition in 1884, had an armature of such low resistance that it had very nearly a constant potential without the use of any series winding. It is a question whether this is not the other extreme; that is, whether it would not have been more economical, as regards cost of material and construction, to make the machine somewhat smaller with a correspondingly higher armature resistance and a few series coils, at the same time letting the machine have the same efficiency and capacity; for, what is lost in the armature may be more than compensated for by the less intense field.

As the self-induction of the armature increases the sparking, it is well to have as few turns per coil on it as possible and a correspondingly large number of commutator strips or coils.

As the magnetic lag of the iron in the armature increases the difficulty of making the machine one of constant potential, this should be as small as possible, of the softest quality, and the number of windings on it as small as practicable.

As it is very desirable not to have to shift the brushes, everything possible should be done to avoid sparking and change of position of the line of commutation; or, what is the same thing, to avoid having to change the position of the brushes. Therefore, in addition to what has been said, the field should not be unbalanced, that is, the iron and coils should be so distributed that the field is symmetrical on both sides of the armature.

Lastly, great care should be taken in constructing compound machines, for if an error or fault shows itself, it cannot be corrected as readily as in other machines by merely changing the speed, coil resistance, or position of brushes, for these changes will change the compounding of the machine, so that it will then no longer have a constant potential.

Although it may hardly seem credible, yet the case has actually occurred in quite a large factory, that magnets were re-wound because the "direction" of the winding of the coils was not correct. It may, therefore, not be out of place here to remark that it is evidently quite immaterial in which direction the magnet coils are wound, as they can in all cases be connected correctly with each other and the poles of the machine. It is evident that there is only one right way and one wrong way, and if a certain connection is wrong it is evidently only necessary to reverse the connections of the two ends of that wire to make it right. The only advantage in winding a certain definite way is that the connections may then be as short as possible and have a better appearance.

It is always advisable in making the test for determining the proper ampère windings, to examine the pole pieces as regards their polarity, with a compass needle (being careful not to reverse the polarity of the needle in doing so), and to note it so that the coils of the finished machine may be connected so as to have the same polarity. Also find which is the positive and which the negative brush in the test, so that the compound connections may be made correctly before the machine runs, as much time can thereby be saved; for it is evident that with certain connections of the magnets with the brushes, the machine will give absolutely no current.

NOTE.—In discussing the subject of the saturation of magnets, in one of the earlier articles of this series, the constant 250 was given as representing, for a particular case, the number of ampère windings passing around a magnet for square inch of cross section of the core when just saturated. It was omitted to state, however, that this constant applies only to such forms of machine magnets as are in general use, and that for certain less frequently used forms it will be some multiple or fraction of this, as will be seen from the following:

Every wire conveying a current around a magnet is encircled by lines of magnetic force, of which those that pass through the armature are rendered useful. In following the course of these lines it will be noticed that most of those generated by one of the two magnets of, for instance, an Edison machine, must return through the core of the other magnet, or in other words, each coil tends to saturate both of the cores of the magnets. This may be more readily explained by the fact that the two magnets of an Edison machine are really the two parts of one and the same U magnet, or they may be considered as one bar magnet bent at its middle to bring the two poles nearer together. In the same way a Weston machine may be said to consist of two such U magnets with their two north poles terminating in one pole piece and the two south poles in the other. This is also the case with the Brush, Jenney, Crompton, Siemens, Schuckert, and many other machines with four magnet coils. The Thomson-Houston, Van Depoele, Hochhausen and like types may also be considered as magnetically equivalent to a pair of U magnets with the coils wound around the two pole pieces which the magnets have in common. The Mather type is quite different from these in this respect, as the entire U magnet is wound with wire. Another distinct type is found in the McTighe machine, in which the two U magnets contain each only one coil at what is frequently called the neutral part of the magnet. It might be compared to a Weston machine in which the two coils of each of the U magnets were placed together as one, on the end pieces or supports, or so-called neutral parts of the two magnets.

The saturation constant above referred to would therefore be quite different for some of the less frequently used types of magnets, unless it is taken as expressing the number of ampère windings on one whole magnet (from pole to pole) divided by the cross section

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of the core of that magnet, or, in other words, if it expresses the allowable number of ampère windings on one whole magnet per square inch of core. If used in this sense it ought to be about the same for all types of magnets, and would evidently be about twice as great, or about 500 for a Weston type of machine.

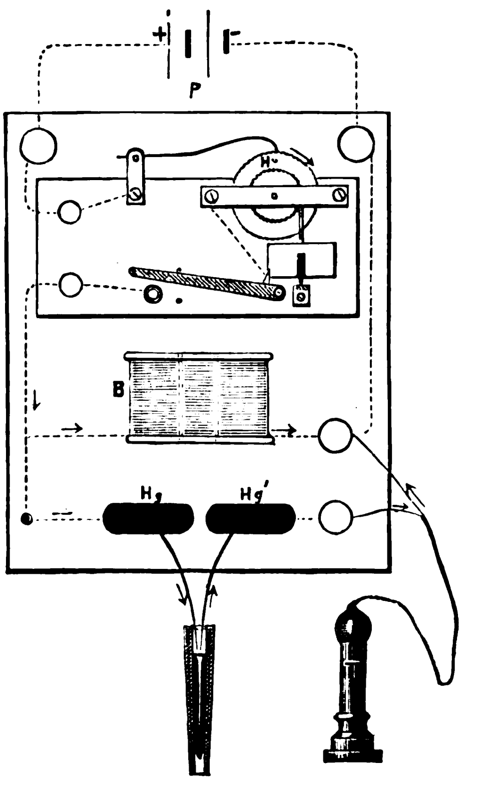
As iron becomes saturated when a certain amount of magnetism passes through every square inch cross section, a better saturation constant than the one used here would be the number of lines of force which may be passed through every square inch cross section of core at saturation. This would overcome the objection to using the number of ampère windings per square inch, as the latter is not the same for all sizes of coils, which is due to the fact that as the area increases the intensity of magnetisation diminishes for the same current.

The constant mentioned in the earlier part of this series of articles, may, however, be safely used, if, as described there, it is determined in each case. It will be found preferable to the other one just suggested, as it simplifies calculations.

It will readily be seen from what was said here about the different types of machines, that if the constant were 250 for the Weston type, it would, if other conditions were eliminated, be 250 in the Thomson-Houston type and 500 in the Mather and McTighe types.

APPARATUS FOR VERIFYING THE MANUFACTURE OF ELECTRIC FUSES.

IN the manufacture of electric fuses for igniting mines —remarks M. Ducretet in *Comptes Rendus*—it has been found needful to ascertain beforehand, by a rapid process, the quality of such fuses, so as to set aside all those which were not certain to act.



To arrive at this result, the fuses must be constructed in such a manner that the extra-current spark of the electric apparatus may strike with certainty in the midst of the composition of the fuse. We must, therefore, ascertain :—1. That the two copper wires are not in metallic contact, which would happen if the protective covering were removed. 2. That the two wires are still so near each other that the spark may strike between them.

These conditions, apparently very delicate, may still be verified in the most complete manner by means of an apparatus which I have constructed. This apparatus consists of a battery, P, of three Leclanché elements, the current of which traverses an interrupter, H, with a clockwork movement, then a bobbin of slender wire, B, and ends in two small cups of mercury, H *g* and H *g'*.

Lastly, a telephone, T, is placed on the circuit in derivation.

When the interrupter is set in motion, and one of the wires of the fuse is plunged into each of the small cups, there is observed in the telephone an unbearable noise, if there is metallic contact between the copper wires. If, on the contrary, the two wires are absolutely insulated, the telephone remains silent; and, lastly, if the fuse is of good quality, we perceive a slight crackling, resulting from the passage of the electricity through the material of the fuse, which contains a large proportion of retort-carbon.

In the last case only, the fuse is recognised as of good quality, and we may feel assured that it will certainly ignite.

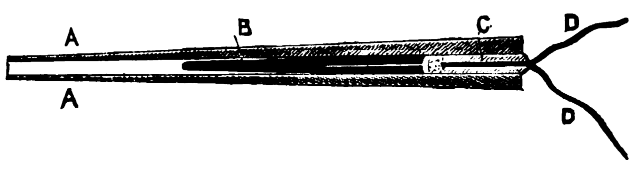
With this apparatus, therefore, we can in a very short time verify a large number of fuses, the resistance of which is higher than a million ohms, and be assured of their quality.

NEW ELECTRIC FUSES FOR THE IGNITION OF MINES.

THE ignition of mines charged with ordinary powder or dynamite — write MM. Scola and Ruggieri, in *Comptes Rendus*—presents numerous difficulties and dangers which might be entirely avoided by the use of our new electric fuses.

These fuses are composed of two copper wires, D, D, covered with cotton and coiled on a small wooden cylinder, C. Round these wires and their support is glued a paper cartridge filled with a priming composed of chlorate of potash, saltpetre, sulphuret of antimony, and retort-charcoal in fine powder; the last-mentioned ingredient serves to give a slight conductivity to the mass.

The wires thus arranged are fixed at the extremity of a paper tube, A, A, which contains a port-fire or a powder-match, B.



If we wish to effect the explosion of a mine charged with common powder, we reserve in the mass a narrow empty cylindrical space, by means of a pin. The fuse described is placed at the upper part of this channel. It is merely necessary to connect the two wires to an induction coil, or, preferably, to the ingenious apparatus known as a "coup de poing," to obtain at the desired moment an extra-current spark which ignites the fuse-paste. The gases produced in this combustion ignite the match and project it with great velocity into the middle of the mine.

If we use dynamite we add a fulminating primer, upon which the match impinges at the instant of its projection.

The use of our new fuses secures the ignition of mines, prevents any accident which might result from their hanging fire, and will, we hope, render excellent services in numerous branches of industry.

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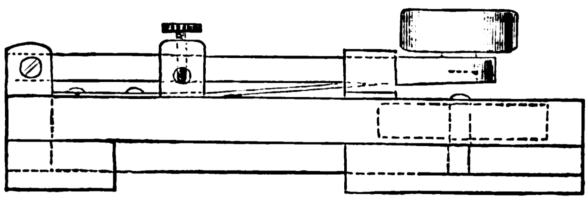
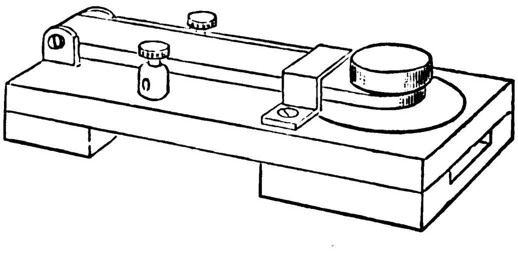
A MAGNETO GENERATOR KEY.

By SAMUEL VYLE.

GENERAL WEBBER'S valuable paper read before the Society of Telegraph Engineers, last year, on the working of the telegraphs in the Soudan, gave practical evidence of the good service rendered by the telephone when used as a receiving instrument; and so much was the Colonel Commandant of the Queen's Edinburgh Rifles convinced of its utility, that he wrote to a contemporary, stating his desire to equip his company therewith, but in an improved form. What he particularly wished to have was the ability to work the Morse code using the telephone as a receiver, *but to dispense altogether with batteries*, if possible. He further said he had enlisted to his aid high scientific authorities in the electrical world. It was by the persusal of that letter that the present writer was induced to attempt its solution.

After many trials to generate currents by some mechanical means, the author discovered that if a pair of Bell telephones be connected up as a closed circuit, and the ferrotype plate be removed from one of them, and the flat edge of this thin plate be tapped upon the magnetic core, within the wire coil, those taps generate currents which are distinctly reproduced in the second or receiving telephone. With a piece of soft iron of greater mass the signals are louder, but both dots and





dashes come out clear, and are as easily read as when a voltaic current is used. With a Gower-Bell magnet and its tiny coils, when tapped with a soft iron key, signals have been read through 30,000 ohms resistance.

Such an instrument was submitted in January last to the then Lord Advocate of Scotland, the Right Hon. J. H. A. Macdonald, M.P. (writer of the letter referred to), who expressed himself as much pleased with the results.

The accompanying key is its own generator, and is submitted for view and trial as admirably adapted for military purposes where the telephone is used as a receiver. Its construction is very simple, being composed of a small horseshoe-shaped permanent magnet; each pole being fitted with a soft iron core, wound with wire to about 50 ohms each, and joined up in series. The handle, or keying part proper is of soft iron, and when depressed against a spring, is brought into direct touch or contact with the magnetised cores in the centre of the coils, and at the same time the magnetic circuit is closed, thereby generating a vigorous current which is of longer, or shorter, duration, according to the time the two metals are in contact. A horseshoe magnet is not absolutely necessary, as when the core of a straight bar magnet is touched, the effect is the same to the ear, as if the magnetic circuit was completed. Touching with a magnet of opposite polarity to the core, gives results similar to soft iron; but if the core be in contact with a similarly magnetised pole, no current whatever results. It is clear, therefore, that mere hammering of the one metal upon another will not generate currents. The core is also dumb when touched with copper, brass, &c. Soft iron, nickel, and the opposed pole of a magnet, are the best touchers of a magnet. Of course much depends upon the size and capacity, as also upon the quantity, size of wire, and the method of joining up the coils. Anything intervening between the soft iron and the magnetised core of the coils, which prevents direct contact between these two, detracts largely from results. On the other hand, by winding the legs of a penny magnet with a quarter of an ounce of No. 40 wire, and tapping the poles with its tiny armature, currents are sent, and signals are quite readable through 5,000 ohms resistance.

From what has been said it is obvious that there are many ways in which this "touch of core" method of generating currents can be utilised; but conspicuous above all is its fitness for military telegraphy, in conjunction with the telephone as a receiver, as batteries are thus dispensed with.

[We may remark that an instrument on a somewhat similar principle to that of Mr. Vyle's will be found described in the No. of the REVIEW for August 19th, 1882. The "touch of core" principle was many years ago made use of by the late Sir Charles Wheatstone, (see TELEGRAPHIC JOURNAL, No. 1, Vol. I.). The principle was also applied by the late M. Breguet to magneto exploders.—EDS. ELEC. REV.]

ELECTRICITY IN THE ROYAL NAVY.

[FROM A CORRESPONDENT.]

THE 150 members of Parliament who, with Captain Lord Charles Beresford as their *cicerone*, visited Portsmouth on Saturday, had an opportunity of witnessing some interesting submarine and electrical experiments, which, though not at the present time of a particularly novel description, serve to mark the rapid progress which has been made in electrical science as applied to naval warfare since the last visit of representatives of the Lower House, now some eight or nine years ago. The morning having been devoted to a sham fight at Whale Island, the M.P.'s proceeded, after lunch, in dockyard tugs to Porchester Creek, where, under the superintendence of Captain A. J. Fisher, of Her Majesty's gunnery ship *Excellent*, assisted by Commander Macleod of the same vessel, an interesting programme was carried out to the manifest amazement of some of the visitors, whose Arcadian simplicity with regard to naval matters afforded no end of amusement to those whose education has been more complete in the matter. The old-fashioned outrigger torpedo boats, in which electrical apparatus was made use of, although not to the same extent as in the newer type of craft, afforded a striking proof of what has been accomplished in a comparately short time. These boats were very carefully manœuvred, and the *modus operandi* of their attack succintly explained. Another operation was destroying electric cables and "bumping" submarine mines. This is one of the latest developments of naval warfare, and was effected by means of a bulky and far-reaching apparatus being dragged over the torpedo grounds by a steam launch, which keeps at the distance of about 500 yards away. On the first mine exploding, the electric cables connecting the others were so affected that they also were destroyed. After this, attention was directed to a second class torpedo boat coming from the head of the harbour in the direction of the tugs in which the "members" were accommodated at a furious speed. Without

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slackening, a torpedo was shot out at right angles and struck the target. A first class torpedo boat afterwards fired two of her deadly charges simultaneously, and both were very near the target. The improvements which have been made of late in the mode of discharging torpedoes by means of electrical apparatus has greatly conduced to a greater degree of precision in aim being attained, and with still further developments in this direction there can be little doubt that almost perfect exactitude will ultimately be reached. Perhaps what astonished the Legislative body most was the explosion of mines. The latter were 2,000 yards apart, and connected by an electric cable. At one end one of the mines was "bumped," and by means of the ingenious electrical apparatus which was made use of on the occasion one at the other end exploded almost simultaneously, sending up a huge volume of water, resembling a waterspout of large dimensions. This experiment was intended to illustrate the manner in which sunken mines, covering large areas, may be exploded from the shore when used for the defence of harbours, rivers, &c. Other experiments of a minor nature were also made, and afterwards the party proceeded to the turret ship *Colossus* at Spithead, and inspected the various minutiæ of that large vessel, which is fitted with all the latest developments which naval science can supply. Electricity is used to a very great extent on board this Leviathan of the deep. It is of course fitted in every part with the electric light, has search lights of the most powerful and penetrating description, its turret is worked by electricity, and its guns fired by the same power. After this the members returned on shore, and left by train for London, after a holiday which the amenities of party politics must have transformed into something delightful indeed.

ELECTRIC LIGHTING AT THE LIVERPOOL EXHIBITION.

In an article upon the Exhibition at Liverpool, the *Times* makes the following remarks upon the electric lighting systems employed :—"Electric lighting forms so important a feature of the Exhibition that some notice of the different systems employed may be useful. Both arc lamps and incandescent lamps are used—the former of 2,000 and 3,000 candle-power, the latter of 10 and 20 candle-power. As these lamps, with relative dynamos, are furnished by five different firms, an excellent opportunity is afforded of comparing, not only the effect of the two kinds of lamp, but also the systems of different patentees. The five firms supplying the lights are Richard Miller, Glasgow, who provides the Thomson-Houston arc lamps; Andrews and Co., Glasgow, the Anglo-American Brush Company, London, Gülcher & Co., London, and King, Brown and Co., Edinburgh. The largest share of the lighting has fallen to the Thomson-Houston system of arc lamps. It is used in the outside lighting of the grounds at the west front of the building, in the grand hall, in the picture galleries, and the eight north-western courts—155 lamps in all. The Andrews arc lamps are used, to the number of 30, in the south-eastern courts, including those filled with machinery in motion. The Anglo-American Brush Company furnishes 55 arc lamps for the north-eastern courts, and 250 incandescent lamps for Old Edinburgh. The south-western courts are lighted with 32 Gülcher arc lamps, and the same company lights the grounds north and east of the building with the same number of lamps elevated on tall masts—four on each. King, Brown & Co. light the central court, which is 750 feet long, with 1,425 incandescent lamps, and the north promenade outside the building with 1,200 incandescent lamps in coloured globes, hung in festoons from three rows of Venetian masts.

"King, Brown & Co.'s dynamos are worked by six Marshall engines, one with two dynamos being a reserve. All the other dynamos are worked in a single court by six engines—four by Robey, one by Adamson, and one by Marshall. The steam power for all these engines is supplied by six large boilers placed in a recess between the 16th and 18th courts on the south side of the building.

"There can be no doubt that, both for brilliancy and steadiness, the palm must be given to the Thomson-Houston lamps. The grand hall and the picture galleries are as brightly and as pleasantly lighted by night as they are by the noon-day sun. Between the other systems of arc lamps I cannot venture to discriminate. They are all good, though none of them can be compared with the Thomson-Houston system. The lighting of the central court with incandescent lamps is not quite satisfactory. The intensity of the light varies, and even at its best it cannot compare in brilliancy with the arc system. It ought to be said, however, that the comparison is not quite a fair one. The equivalent of 1,425 incandescent lamps of 20 candle power, is only 9½ arc lamps of 3,000 candle-power; but if the central court were lighted with arc lamps in the same ratio as the side courts are lighted, not 9½ but 44 arc lamps would be employed. In this view, it may be maintained that the incandescent system is the more economical, and that its comparative failure is due to the fact that too few lamps have been employed. Certainly the vista afforded by the central court when lighted up is very fine as a pyrotechnic display. Much the same may be said of the illumination of the north promenade. The combination of colours is very effective; but the lamps do not light up the promenade. The lighting of the shops and houses of Old Edinburgh with the incandescent lamps of the Brush Company is much more successful than that of the central court, but the limited areas that require illumination may tend to produce a more favourable result. Altogether, the electric lighting of the Exhibition is a notable success."

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.

(*Continued from page* 521.)

Wednesday, May 12th, 1886—(*continued*).

Mr. JOHN IMRAY, cross-examined by the Solicitor-General: I ask you to turn again to M. Sidot's paper. Those who instruct me were rather surprised at one or two answers which you gave. "Differing also from this last in regard to conductibility for heat and electricity." In that passage he has compared carbons which he produced in the mode he described with other carbons, in respect of conductibility and in respect of elasticity?—No. In respect of the conductibility of heat under electricity, and also in respect of elasticity.

He is comparing the carbons which he has produced in the method he has described with other carbons in point of conductibility, and in point of both heat and elasticity?—Yes.

I am quite aware that you want for a conductor in an incandescent lamp a material of high specific resistance, and you will probably tell me that carbon is a suitable material for this purpose; but amongst carbons it is good to have a good conducting carbon, is it not?—Well, a uniform conducting carbon.

But a good conducting power—otherwise it will not carry the current—will do?—What you want is resistance.

But you do want your current carried through, do you not?—Yes.

I will refer to this passage, which I think you have misunderstood: "Pencils made from this give a much more intense electric light than those which are obtained from gas retort carbon." He is there speaking of electric light giving pencils?—The arc light.

You keep on repeating the words "arc light." If you had waited till my next question you would have seen it was not necessary to have been so anxious to repeat them. Is there anything in that language, "pencils made from this give a much more intense electric light," which in itself, according to the literal meaning of the words, is more applicable to the arc light than to the incandescent light?—Yes. There are a few words which show this distinctly, because he compares them with the carbons made from gas charcoal, and all the carbons made at that time were made from gas charcoal.

C

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And also for incandescent lamps ?—There were no incandescent lamps made at that time.

Did not King, in the year 1845, describe an incandescent lamp with a carbon conductor made from gas retort carbon ?—Yes ; and many other people have described it, but it never was commercially used.

I am not asking you that. "This carbon conductor becomes heated in the same manner as a metal, and becomes gradually incandescent over its whole surface." Now, you told Mr. Moulton that the conductor did not become gradually incandescent, but that it became incandescent all at once ?—Yes ; throughout its whole mass.

I speak with some diffidence ; but that is not scientifically or theoretically true, is it ? You cannot measure the distance of time which the electric spark takes to pass from one part to the other ?—It is so rapid that one cannot measure it.

But still, theoretically it does pass through, and it is only that it passes so rapidly that you cannot measure it ?—I suppose so.

Let me ask you whether the meaning of it is not this, that the heat first causes a dull red light and then becomes more incandescent ?—No, that is more inconsistent with the language.

I am asking you whether it is not a fact that when you light a carbon conductor it first glows with a dull red light and then progresses gradually into incandescence ?—Yes.

Must not this language be referring to it becoming gradually incandescent over its whole surface ? That is to say, from what I venture to call a dull red light into a bright incandescence ?—No ; because it contrasts the doing of it throughout its whole mass with doing it at one point.

Let me read the whole sentence to you. "And becomes gradually incandescent over its whole surface without becoming bright at any particular point." Does not that mean this, that it becomes gradually incandescent over its whole mass, instead of becoming irregularly incandescent, brighter at one point than at another ?—No, I think not.

Is not this [pointing to the lamps in the court, just now lighted] progressively incandescent ?—Progressively in point of time, but not in point of length.

Mr. MOULTON : Those are the ordinary carbons, not Sidot's.

Mr. JUSTICE BUTT : That is rather a striking passage about it getting cold when withdrawn from the fire.

The SOLICITOR-GENERAL : The way it is translated is that it becomes cool immediately you remove the heat, and the French is "*aussitot qu'on retire du feu*."

Mr. JUSTICE BUTT : I understand the witness to say that that is the view he takes about it, that he is not talking about electricity at all, but fire.

The SOLICITOR-GENERAL : I will not take up your lordship's time by arguing that with Mr. Imray.

Mr. ASTON : I think the language would show that it is retiring it from the fire.

The SOLICITOR-GENERAL : It is no doubt "retire it from the fire," whatever that may mean. I am sure your lordship will appreciate the witness's suggestion that that indicates to him that the heat spoken of was not by the electric current, but ordinary heat. [To witness] I will refer you to page 2 of Scott's specification of March 2nd, 1878, No. 249 : "My invention consists secondly in manufacturing flexible bands, ribbons, or cords of carbon, or mixture consisting essentially of carbon, to be used as hereinafter described in the production of light by electricity. I take the carbon or carbon mixture and incorporate therewith fibres of asbestos or fibres of hemp or other mineral or organic fibres, together with adhesive matter as hereinbefore explained. By rolling or otherwise I form the mixture into long bands, strips or ribbons and dry them with heat." Could you not employ these flexible ribbons, strips or cords of carbon or mixture consisting essentially of carbon, as carbon conductors in an incandescent lamp ?—I think when you are shown the way you could.

Is there anything to show you ? Could you not cut off a piece of Scott's ribbon and put it between two platinum wires and enclose it in a vacuum ?—It would make a very large incandescent lamp.

Very likely. But suppose you made one of his cords or wires very small ?—Yes. He does not carbonise afterwards.

He carbonises first ?—He makes the carbons first, but he does not carbonise after he has given them the form.

That is quite true ; but does he not suggest to you a mode of manufacturing carbon ribbons, strips or cords which are capable of being used as carbon conductors in an incandescent lamp ?—I do not think they would do unless you carbonised them afterwards.

Do you suggest that for a carbon conductor, so far as conductibility is concerned, it makes any difference at what period the carbonisation takes place ?—Yes ; it makes quite a different thing to the constitution of the cord.

Supposing you had a carbon strip of any kind and put it into a vacuum with the platinum wires, would not that be a carbon filament ?—That would be a carbon filament.

You said Edison and others had used lamps with metallic wires, and that he now proposed to substitute carbon wire, the advantage of which was that it could be bent and turned upon itself into a loop, and by using a filament sufficiently flexible for that purpose before carbonising and sufficiently stiff after carbonisation to retain the form ?—Yes.

Will you point out to me any passage in Mr. Edison's specification in which he points out those requirements, except with regard to the spiral. I am quite aware of the passage with regard to the spiral, and I do not want to have that put upon me ?—Well, that is turning it upon itself.

It is then only with regard to the spiral that he points out the desirability of its being flexible before the carbonisation and stiff afterwards. Is that so ?—Yes ; it must be flexible. He describes flexible materials to be used.

For making the spiral ?—Yes ; or even without the spiral.

I should like to know where that is. On page 4, line 39, he says that he has carbonised and used linen thread, wood splints and paper coiled in various ways. Then he points out to you there what you told us you found in this patent, that it must be a substance sufficiently flexible to receive its shape before carbonisation, and after carbonisation sufficiently stiff to retain it ?—Yes, because he describes certain things that have that, and he has shown in his drawings the form that he describes.

But in the drawings he speaks of nothing but the spiral ?—Only the spiral.

Then it is only from his mentioning cotton thread or any fibrous vegetable substance which will leave a carbon residue after heating in a close chamber, that you infer that ?—Yes ; he wanted to substitute a carbon filament for a metallic wire, and it ought to have the same qualities in that respect as the wire that has to be bent to the shape first and carbonised to retain that shape afterwards.

But he has not told the world, except so far as it is implied in the words, "A fibrous vegetable substance," that it was to have those qualities ?—Yes ; he tells you he makes an artificial carbon. It is a carbon wire, and he tells you that he uses other things, such as cotton and linen thread, and wooden splints, all of which have those particular properties.

But he does not tell us, except in your inference from the materials which he suggests, that the essential thing is to have a carbon filament which will be flexible before carbonisation, and rigid afterwards ?—Not in so many words.

In this passage which you refer to he is only speaking of a fibrous vegetable substance in connection with its being coiled ?—Yes.

And the passage to which Sir Richard Webster referred in his opening, "the spiral after carbonisation retains its form," only applies to the spiral ?—Yes ; but, of course, it would apply *a fortiori* to other forms.

Is there anything whatever with regard to the spiral in which Edison has either pointed out a preferable shape, or, still more, confined himself to any shape ?—No, there is not.

So that a straight conductor would be equally within his patent as any other shape ?—I do not think it would ; it would not answer the purpose he has in view.

That is your opinion as a scientific man ; but I am asking you, as an experienced person in patents, whether Edison's patent claims any preferential shape, or any shape at all ?—No, it does not claim a preferential shape.

Nor is there a single suggestion that you should shape your fibre before carbonisation, except with regard to the spiral ?—No.

I think I might go a little further and say that in Edison's later patent he does describe a mode of making a carbon filament stamped out of Bristol board ?—I believe so.

But in the patent sued upon he does not give you any mode either of making it or carbonising it, except with regard to the spiral ?—No.

He does not give you, for instance, any model or block, or any process by which you are to get a particular shape, or indicate to you how you are to get a particular shape, except with regard to the spiral ?—No, he does not.

Or at what stage its shape is to be given to it ? —No ; but he said before carbonisation, certainly.

That is a fallacy which Sir Richard Webster has suggested. There is not a word in the patent about it. He says on page 4, line 42 : "If the carbon thread is liable to be disturbed during carbonisation," and so on.—He shows distinctly how it is to be coiled before carbonisation.

Is he not there speaking of the spiral ?—Yes.

I ask you, excepting with regard to the spiral, is there any indication with regard to the carbon filament *simpliciter* as to the stage at which it is to receive its shape ?—No, of course not ?

Now, as you referred to the figures just now, I will ask you whether reference to the figures and the detailed description of burner does not relate only to the spiral ?—It shows only the spiral.

Perhaps it is an unfair suggestion on my part, but do you think that the filament of carbon of high resistance, made as described in the first claim, means the detailed description which is given in the letterpress and in the figures ?—Yes.

Exclusively ?—Substantially.

You understand what I mean : that is, the spiral only ?—Oh, no, no ; the spiral he says is a preferential form, and then he makes a special claim for it, but he does not confine himself to that at all. He says, I prefer the spiral form for reasons which I give, but I should have a filament, whether spiral or not.

You suggested that one of the great advantages of this was that you could have both wires at one end of the receiver, instead of passing out at separate ends ?—Yes.

I have no doubt you are quite right ; but there is nothing about that in the patent ?—No ; but he shows it in his drawings.

There is nothing which would enable him to claim that as one of the advantages which he has pointed out to the public ?—I think he has pointed it out clearly in his drawings.

But there is nothing in the letterpress, is there ?—Not in the letterpress, in any words which I can see, except the description of the drawing.

But the drawing, you told me just now, is only a drawing of the spiral ?—That shows the spiral only.

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Re-examined by MR. ASTON: You are asked whether in Edison's specification he describes any mode of manufacturing a filament otherwise than in connection with the spiral. In your opinion would the description which he gives of the manufacture of a filament with the view of its being formed into a spiral be sufficient to make a filament such as is in any of the lamps now before his lordship?—Yes; it is only a spiral with one or two fewer turns. It is only a question of the number of turns.

As regards the preparation of the filament and its character when made, is there any difference between this filament with one curve and that with two or more curves?—No; it is the number of convolutions.

The SOLICITOR-GENERAL: Sir Richard Webster opened his case by saying that they did not charge infringement with regard to the spiral.

MR. ASTON: I do not say that. If I understand the Solicitor-General's questions, which were very close, they were to the effect: "Is it not a fact that the description here given of the preparation of the filament is a description which only applies to the spiral?" and the witness said "Yes." I think it is fair for me to ask, Is the description given as to the spiral sufficient for the preparation of the filament in any other form required for an incandescent lamp?—Certainly; you may have one turn or 20 turns of the spiral.

As regards the directions given by the specification, are they sufficient for the preparation of both forms?—Yes.

As far as I understand your answer to the Solicitor-General, you said that in your opinion the filaments referred to in the first claiming clause need not be spiral filaments?—No, I think they need not.

Would the conditions for an electric lamp be answered whether the filament had one turn, two turns, or more?—Yes.

Were you in court when Sir Fredk. Bramwell was asked as to the meaning which he attached to the specification No. 5,127 of Edison for 1879?—Yes, I heard it, I think.

Do you agree with Sir Fredk. Bramwell as to its being a further improvement founded upon the substratum of 4,756?—It describes a particular carbon made of paper.

You were asked whether there was any description of the mode of carbonisation save and except as to the spiral. As to the spiral there is a description, is there not, as to the mode of carbonisation?—Yes; not a detailed description, but still a sufficient one. It tells you that you are to put it into a closed vessel and subject it to heat, and thereby reduce it to carbon.

Would those directions be sufficient for the horseshoe shape or any other shape?—For any shape. It is a well-known process of carbonisation; it was known long before this.

What in your view would be the meaning attached by a person acquainted with the subject matter to the directions that are there given as regards the character of the filament that would be produced?—What I say is, they must make it flexible to begin with, and carbonise it; put it into its shape and then carbonise it.

Whether the words are omitted or not, do I understand you to say that the directions given would of necessity relate to any other flexible and elastic carbon filament?—Yes; because he mentions nothing but what is flexible.

The Solicitor-General read to you that passage in Scott's specification from "My invention" down to "dried them with heat," and asked you whether, in your opinion, that filament was suitable for, or could be used in an incandescent lamp. Having regard to the fact that it goes on to say that when the fibre is mineral the heat applied may be sufficiently high to decompose the flour or starch base, but when organic fibres are employed the heat employed must not be so high as to decompose those fibres; going on, and bearing that in mind, do you now say that the filaments would be suitable for an incandescent lamp?—No; I said he did not intend to carbonise, therefore it would not be suitable.

Turning to Edison's 2,402, of 1879, the Solicitor-General asked you whether the carbon sticks that are referred to may not be carbon sticks capable of being used in incandescent lamps. I ask you to read that:—"Carbon sticks may be also freed from air in this manner, and be brought to a temperature at which the carbon becomes pasty, and if allowed to cool is very homogeneous and hard. Rods or plates made of mixtures of finely divided conducting or non-conducting materials may thus be freed from air." Now, having regard to the fact that in juxtaposition carbon sticks, rods, and plates are referred to, what do you say is the inference a practical man would draw from the words and statements therein made?—I should say for arc lamps, because all these things had been used in arc lamps at this time.

Now, although carbon sticks may have been used in incandescent lamps, sticks of carbon would not be a form of carbon likely to be used, because you are told in all cases to make them as thin as you can, are you not?—Yes; I do not think it would be very likely to be used.

Are the directions which are given for the preparation of carbon conductors, as a rule, to thin them down?—Yes.

What were the means employed up to this date to produce a thin carbon rod or pencil?—Sawing or filing down.

In what state was the mass of carbon usually from which those rods or pencils were prepared?—As hard and homogeneous as possible.

And as regards form?—Well, very much larger than the finished form.

As they were clipped off from the retort, I suppose?—A very crude form.

It is a kind which one finds commonly in gas retorts when gas is made?—Yes. Great masses adhering to the sides of the retort and having to be chopped off with chisels. They come out in a crude form like great lumps of coal, and are then cut into shape.

MR. ASTON: I should like to ask your lordship's permission to try one of Gimingham's lamps in court, if your lordship will allow that to be done to-morrow. The lamp will be prepared with Gimingham's terminals, and your lordship will see the effect of it.

The SOLICITOR-GENERAL: Of course your lordship will do anything, and I will consent to your lordship's doing anything, which you think will be of assistance to the court, but I am bound to say I do not think an experiment of that kind would be in the least degree useful, and it only shows a misapprehension of what I have been endeavouring to get the witnesses to prove, that after the heat has been applied for any length of time the joints become loose and useless. Trying it for ten minutes or a quarter of an hour will not be the slightest answer to my suggestion. But I do not oppose any experiment your lordship thinks desirable.

MR. JUSTICE BUTT: I am rather opposed to experiments of that kind, because they are endless, if you once begin with them. If you wish to suggest it further on you may do so. There seems to be that objection, that it may answer perfectly well for an hour or so, but unless I can sit here for a week and look at it, I do not think I should derive much benefit from it.

The SOLICITOR-GENERAL: And this would be a specially made one.

MR. ASTON: Another question I should like to ask the Solicitor-General is with reference to the proving that the combination was made by Edison in the regular way, and that he filed his declaration in the regular way, and that the complete specification is filed. I do not know whether my friend will put me to the necessity of calling Mr. Brewer.

The SOLICITOR-GENERAL: Oh, no.

MR. ASTON: I am putting this question because I do not propose to add to the scientific evidence already given, except to ask Prof. Dewar a few questions about the construction my learned friend is putting upon Sidot, which rather takes our scientific witnesses by surprise.

(The Court then adjourned for the day.)

Thursday, May 13th, 1886.

Professor JAMES DEWAR, F.R.S., Professor of Natural Experimental Philosophy at Cambridge, and Professor of Chemistry at the Royal Institution, examined by Mr. Aston, said he had since 1872 made a series of special investigations on the properties, physical and chemical, of carbon at high temperatures. About 1879–80 he made a series of practical experiments with reference to the effect of heat upon carbon. He read Sidot's papers in 1879, having at that time great difficulty in discovering any method of getting over the natural inequalities of carbon—the chinks and holes, and porosities. His object was to use carbon in the form of tubes, and these tubes he wanted to resist a certain small amount of gaseous pressure; for that purpose he tried all varieties of carbon, ordinary gas retort carbon, carbon produced by hydraulic pressure, and various means, and special carbons were made for him by the late Sir William Siemens, but all showed the porosities; therefore he read up the literature as far as possible, and tried to devise some means of filling up the pores. When he saw M. Sidot's paper on the advantages of disulphide of carbon he naturally tried the method which Sidot described, and he now produced some tubes which he used in the original application. He did not know at that time of any means of obtaining carbons taken from a gas retort in the form of a long cylinder of very small section, having flexibility and elasticity; but during his experiments he formed what Sidot described at the end of his paper. Sidot's paper was on the action of disulphide of carbon and carburetted hydrogen on wood charcoal. Witness placed his imperfect tubes, some of which were made of compressed carbon, and some of drilled gas retort carbon, in the interior of a porcelain tube as described, heated up to a white heat, and passed over these various kinds of carbon, the vapour of disulphide of carbon, or of some hydro-carbon. The surface of the interior of the tube became coated with an irregular deposit of a dense variety of carbon, as Sidot described it.

MR. ASTON: Did you at that time treat anything of so small a section as to have a filamentous character?—No, not at that time. I ought to say, however, that the description which he gives in the last sentence, in which he refers to the growth of something like a filament on the walls of the tube, was perfectly familiar to me, and it is an actual fact. Here is a specimen of a porcelain tube which shows this particular growth which he calls filamentous.

Is there anything there of a globular character?—Yes; when you look at it with a lens you can see that these so-called filaments are evidently the growth of a succession, I take it, of small bituminous bubbles. Sidot calls them "*petites boules juxtaposées.*"

Can you show my lord a deposit which answers to the character given to them by M. Sidot when he says "*les filaments paraissent etre formes par des petites boules juxtaposées?*"—Here is a section of an actual porcelain tube which I used yesterday, in which you will see this growth. If it is looked at with a lens, you can see the so-called filaments have this character, but it is much more apparent where the operation of M. Sidot has been applied to a carbonised filament.

MR. JUSTICE BUTT: I suppose there is a want of continuity

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throughout?—Yes; there is continuity, but you will see it very slightly in this specimen.

Mr. ASTON: Before I put the question whether Sidot's process would answer for preparing a carbon filament for an incandescent lamp, let me ask you to tell my lord what further experiments you have made in order thoroughly to enable you to answer that question.—I took a quantity of common linen thread and carbonised it. I placed it in a porcelain tube in the middle of a furnace, and I passed over it the vapour of a hydro-carbon. The result is the growth of these irregular filaments, the deposition of this conductive carbon on one portion of the carbon filaments.

The deposits were irregular?—Quite irregular, one portion only of the original fibre being coated with the new deposit.

Now, I put the question to you whether Sidot's process, having regard to the results you have obtained, both in 1879 and yesterday, enables carbon filaments to be made such as are described by Edison in his patent?—Certainly not, because they are irregular and brittle.

Would they be suitable for being used in an incandescent lamp?—Absolutely useless, I should think.

Mr. JUSTICE BUTT: I am expressing no opinion whether it does or not, but if Sidot's results would be of no assistance whatever in the forming of an incandescent lamp, then Sidot does you no harm. I shall hear the cross-examination, but so far as it has gone I gather Prof. Dewar's evidence to go directly to that.

Mr. ASTON (To witness): Now, there are references to conductivity in this paper?—Yes.

What kind of conductivity do you say Sidot was referring to and investigated?—In one part he says that this particular conductive carbon is distinguished from ordinary carbon by its greater conductivity both for heat and electricity.

Did you make any experiments for heating carbon by passing an electric current through it?—I was in the habit of doing so daily.

But with reference to this particular experiment?—No, I regret to say it never struck me to use electric heating in the presence of an atmosphere of hydro-carbon.

Why do you say you regret to say that?—Because if I had known that I could have got the deposit just where it was wanted for my purpose. I was not looking for incandescent lamps; I wanted to get a very small tube made fairly tight.

And the deposit uniform?—For my purpose, if I filled up the irregularities, that would do.

Mr. JUSTICE BUTT: Does Sidot heat by electric current?—No; he says he introduces pieces of wood charcoal, and then passes the vapour first at a low temperature, and then heats gradually.

Mr. ASTON: When comparing wood charcoal with prepared charcoal, as regards conductivity, do you think that conductivity had any reference to the passage of an electric current?—Not in the passage that was referred to yesterday.

Why not?—Because it is quite incompatible with the other parts of the sentence.

Would wood charcoal have any conductivity of any appreciable character?—Wood charcoal has no conducting power of that kind that anyone could apply for incandescent illumination.

Having had your attention called to all these circumstances, is there, in your opinion, anything in Sidot that would lead any person to treat a carbon filament by passing an electric current through it and heating it in a carbon atmosphere?—No.

Cross-examined by Mr. CHARLES: Does your answer as to incompatibility apply to the last paragraph of the extract?—It does.

And to the paragraph commencing: "The same carbons?"—Yes.

"The same carbons, which are distinguished so completely by their elasticity from ordinary carbons, differ also from these last in their great conductibility for heat and electricity. Pencils made from this give a much more intense electric light than that which we obtain from gas retort carbon. This carbon conductor becomes heated in the same manner as a metal, and becomes gradually incandescent." That is "this carbon conductor" of electricity, is it not?—No; that is not my translation. Of course, I do not pretend to be a thoroughly linguistic French scholar, but I translate it in the way which was right to my mind, and is right now. It means "this conductive form of carbon."

Mr. JUSTICE BUTT: It is quite clear that the word *conducteur* is the adjective; it is carbon which conducts. That is my translation of it.

Mr. CHARLES: I don't care which way I take the translation. The conductivity of that carbon had been described in the previous paragraph, had it not, as a conductor of heat and electricity?—No; he says in the previous paragraph that it has both those qualities, and he refers then specifically to its conductivity for electricity when he says he believes he could replace the carbons in the Bünsen piles.

Why, when you read those two sentences together, should you cut down the meaning of the words "this conductive carbon" to mean "this carbon conductive of heat?"—Simply because the rest of the sentence tells the chemist what he means. He says this conductive carbon becomes hot in the same way that a metal does, and he says it becomes progressively incandescent in the whole of its mass, and he contrasts that property now with the ordinary carbon, which he says has not that property. Now, if an ordinary carbon has not that property it is quite clear that he is contrasting some other property of carbon, because the ordinary carbon has not electric conductivity, so it cannot refer to that.

Mr. JUSTICE BUTT: And he says it cools immediately he withdraws it from the fire.—That refers to the well-known property that wood charcoal inserted in a fire and withdrawn from the fire will not cool in a body, but cools irregularly, with combustion at various points. I will show you what I mean. This is a piece of Siemens carbon, and there is a piece of ordinary wood carbon, which has been inserted for a few seconds and taken out. You see that combustion takes place at points of this from the formation of the ash, whereas this piece of Siemens carbon has no ash on it at all. It heats up uniformly, and it cools down uniformly. That is all he means. It is a simple elementary chemical fact.

Mr. CHARLES: I understood you to say just now that wood charcoal was not a good conductor of heat?—Not for practical use for the purpose of an incandescent light.

Is not bamboo thread carbonised wood charcoal?—Yes.

Is not that a material Edison uses in his lamp?—That is quite true, but the wood charcoal he is referring to is clearly a variety of ordinary wood charcoal which is well known not to have that property, and otherwise he would not contrast it with that.

Does not the conductibility of wood charcoal vary a great deal with the wood you use, whether it is close or not?—It does, with the density of the carbon.

If you get a dense wood, wood charcoal may be a conductor of electricity?—It might, but he says here ordinary wood charcoal, and therefore he does not mean any specifically dense wood charcoal produced from *lignum vitæ*, or anything of that kind. He uses the words "ordinary carbon." Any other carbon would be more expensive.

He gives several instances of the woods which he would use?—Which he did use.

"The substances of the most different woods, such as box, ash, elm, lilac, alder, and cork can make this new carbon."—Yes.

You did not in your experiments, I think I understood you to say, use wood carbon?—I did not. I had no object in doing so. It would have been useless for my purpose.

There is no doubt, is there, putting aside for a moment whether it is suitable for an incandescent lamp or not, that this process of Sidot's is a process by which a carbon filament was made?—Yes; of a kind which I have described.

Mr. JUSTICE BUTT: Apart from what M. Sidot has said should you call it a filament?—No.

Mr. ASTON: "*Petites boules juxtaposées.*"

Mr. CHARLES: I am talking of the process described in the earlier part of the paper. What would you call his carbonised thread? Sidot says he has reached the same results with thread, hemp, cotton, paper, and silk. Why would you not call the carbonised thread a carbon filament?—I would simply say that the difference is this, that if it was a filament when it was inserted it certainly is not a filament when it comes out of such a process.

It may be a carbonised filament?—An irregularly carbonised filament.

Mr. JUSTICE BUTT: Do you not agree that when he speaks of "these filaments" he refers to all filaments which he produced, whether from thread, silk, or cotton.

Mr. CHARLES: No, I think not.

Mr. JUSTICE BUTT: Then I have misunderstood it. I understood it so, and I understood it to mean that all the filaments he produced were composed of what he calls "*petites boules juxtaposées.*"

Mr. CHARLES: I think not, my lord. I think he says: "This carbon in fact presents itself in the form of filaments of one centimetre in length constituting a kind of silky and frothy coke white like silver. These filaments appear to be formed of little balls touching one another."

I answer your lordship by saying that the words "these filaments" there meant the filaments lastly mentioned by Sidot. I am going to ask Professor Dewar this: Does he not indicate a mode of preparing a carbonised thread? I will come to the irregularity afterwards.—I presume that he means that he did use there these various substances in a carbonised form.

What distinction do you draw between a carbonised thread and a carbonised filament? What is a filament but a thread?—I think a filament means a very fine thread.

That is the only distinction you can make?—That is the real distinction.

Does not the simple word "thread" convey to your mind the idea of fineness?—Not in the same way that filament does. That is not the way that the word filament is ordinarily employed. In physiology nervous filament refers to something very much thinner than thread.

You do not agree with Mr. Edison's view when he uses indifferently the words "filament or thread?"—I say that "filament," to my mind, conveys the idea of a fine thread.

But the degree of fineness you cannot tell us?—No.

At all events you would say the only distinction between the two words, if there is a distinction, is in the degree of fineness of the material?—I think so.

Mr. JUSTICE BUTT: This is all very fine, but what I want to get at is this: When M. Sidot speaks of treating linen, cotton, silk, and so on, by his process does he get, when that material is carbonised, a filament of even texture throughout, or does he get the *petites boules*.

Mr. CHARLES: No, he does not get the *petites boules*.

Mr. JUSTICE BUTT: I want to know whether this paper really means to say you get a continuous, regular filament over those substances.

Mr. CHARLES: I think I have got the witness's view. (To the Witness): I understood you to tell me that, looking at the last sentence, which commences with the words "spirit of wood," the filaments there mentioned in the last line refer to the filaments

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mentioned in the last line but one, namely, those of one centimetre in length, constituting a kind of silky and frothy coke. My lord suggests that in the last sentence, "these filaments," mean all the threads as well as the filaments.—Certainly not. It specifically refers to the production——

Mr. JUSTICE BUTT: That answers my former question, but not my present one. I shall ask the professor sooner or later whether he could get anything more even and continuous from his linen and paper material than he would in that.

Mr. CHARLES: In the case of the thread there would be a fibrous foundation?—There would be what his lordship has seen, the basis of the carbon filament before, and there is the result afterwards.

The basis of the carbonised filament, of course, would be there?—And there you have the other filaments which he describes deposited on it with an irregularity of appearance.

Mr. JUSTICE BUTT: I understand he has stated that whether you take the material described in the last paragraph or the threads of linen or silk in the former paragraph, you will only get a filament, if you choose to call it a filament, composed of *petites boules juxtaposées*.

WITNESS: Perhaps I would make it clear if I explained to my lord the origin of these small balls. The ultimate deposition of carbon does not take place in one stage. There are a large number of intermediate bodies formed, and the ultimate substance that gives the carbon is of a bituminous character, and the consequence of it is that it is small quantities of bituminous material which is deposited, and during that time it is plastic, and as the gases give off from it and deposit carbon it grows in that way, and that is the reason he describes exactly what took place.

Mr. CHARLES: The question I put to you is this, whether the carbonised thread is not continuous?—If you mean the original thread of Sidot's process, certainly not. It is continuous in one sense, but not continuous in the electric sense.

Mr. JUSTICE BUTT: I understand your evidence to be this, that whether we take one of M. Sidot's materials or another the result is a filament, if filament it be, composed of *petites boules*?—That is what I mean.

Mr. CHARLES. That is your view?—That is the result of experiment. It is no view of mine.

I want to ask you a question about the irregularity of the thread produced. I use the word thread because I am dealing with the earlier part of M. Sidot's paper.—You mean the irregular result after the Sidot process?

Yes; it wants homogeneity; it is uneven?—It is uneven in form.

In other words, it is thicker in one place than it is in another?—Yes, it varies in shape.

Was not that one of the difficulties which, up to 1878, existed and prevented the use of carbon in an incandescent lamp?—Yes, the irregularity and the impurities in it.

Is there anything in Mr. Edison's patent which indicates that his process would produce a regular filament?—I am sorry to say I have not specifically studied Edison's patent.

Are you are aware, apart from Mr. Edison's specification, that since the reading of M. Sidot's paper a mode has been described of removing the irregularity of the carbonised thread?—I am.

Is there any reason, and if a reason, what is it, why the irregular carbonised thread which could be produced by following M. Sidot's process should not be made regular by the subsequent discoveries? In short, why should not the process of flashing be applied to M. Sidot's irregularly carbonised thread?—What do you mean by flashing?

Mr. JUSTICE BUTT: The process which has since been discovered.

Mr. CHARLES: Which is of making the thread homogeneous?—I say I am aware of the process, but I have not studied Mr. Edison's patent. I ask you what you mean by the word flashing?

What I mean is this, the process by which the carbonised thread or filament is made homogeneous.—You mean, I suppose, by electric incandescence in an atmosphere of these hydrocarbons? That is what you mean by flashing?

Yes.—Then I say that I believe and know that that can be successfully conducted.

Is there any reason why it should not be successfully applied to irregularly carbonised thread?—I think it would be ridiculous. It would make the thread very much worse than when you put it in, and consequently if you applied the new process to the result of Sidot it would simply be putting the cart before the horse.

I do not quite know what the right word to use is, but would not the process now known of making an irregular filament regular be a process which could be applied to Sidot's filament?—I am not prepared to say. I never tried it in a Sidot filament, and it would not be very easily done.

Mr. JUSTICE BUTT: Then you do not say whether flashing, as it is called, can be applied to a Sidot filament?—I can conceive it might be applied. I should think it very ridiculous, because Sidot's process makes the thread much more irregular than it was, to begin with.

Mr. CHARLES: What is there to prevent one of those carbonised threads, which you produced yesterday, being attached at either end to platinum, and a current of electricity passed through it in an atmosphere of carbureted hydrogen, which is the very process which produces regularity? Why should that not be done?—I never said it could not be done. I only said that is not Sidot's process.

I know it is not Sidot's process, because it was not used in the year 1870; but what I want to know is this, is there any reason in the world why one of these carbonised threads should not have a platinum wire attached to either end of it, and an electric current passed through it in an atmosphere of carburetted hydrogen?—If you wanted to do it, and there were any object, there would be no reason why it could not be done.

Mr. JUSTICE BUTT: That is Sidot's?—No; that is a filament before the Sidot process.

Mr. CHARLES: I am talking of the one after the process.—What was placed in my hands was one before. I did not understand that you meant after. I made a mistake in answering the question.

Why should not that be so?—I say there is no reason why, if you can get these filaments separate, you should not pass an electric current through it.

In an atmosphere of carburetted hydrogen?—Yes.

If that were done would not the irregularity disappear?—No; I think these filaments are far too irregular, both in the interior when you take a cross section, and in their outer forms, for any such process ever to produce a uniform conducting medium.

You have never, you told me, made such an experiment?—No; because I am quite certain it would be a failure.

Mr. JUSTICE BUTT: What is the reason?—From the great irregularity of both inside and out.

Mr. CHARLES: Is it a matter of degree of irregularity there that you rely upon?—Certainly, because the principle that you are going to apply depends entirely on a certain amount of irregularity; but in these Sidot's filaments you will observe that all these little ball growths are at right angles to the direction of the original filament, and there is such an amount of irregularity that instead of getting something of the diameter of your original filament, you would get something of five times the diameter.

The object of the process is to remove irregularities from this carbon filament, is it not?—That is what I understood you were asking about.

Mr. JUSTICE BUTT: He says it may be done with an ordinary carbon filament, but that it will not work what you seek to work out upon the filament treated by Sidot's process.

Mr. CHARLES: That is his opinion. He has not tried it. Will you kindly tell me what you did in making your experiment yesterday, because I do not feel that I have quite grasped it?—What I did was to follow the directions given by Sidot to deposit this conducting carbon by the method which he has described, inserting in a porcelain tube and passing a current of a vapour of hydro-carbon over it.

How long did you continue the process?—The process was continued for about three hours, that is to say, from the time of heating up the porcelain tube. You cannot insert it in a furnace and get it instantly hot.

Did you pass a vapour of a hydro-carbon over it?—I did.

Does Sidot do that?—He does.

Will you kindly point out where?—In the last paragraph.

I am talking of the earlier part. He says: "Wood spirit and hydro-carbons would behave exactly in the same way."—I have tried disulphide of carbon if that is what you want.

Turning to the last clause, "spirit of wood, carburetted hydrogen, &c., also changed a wood into carbon elastic and conductive." Does carburetted hydrogen there, in the chemical sense, mean hydro-carbon gas?—It means hydro-carbon gas, undoubtedly.

Not a vapour?—A vapour is a gas.

Did you begin with a carbonised thread?—I did. I carbonised it before I placed it in the porcelain tube.

Mr. JUSTICE BUTT: As I understood, he carbonised a hank of thread, and then with the half of it, he operated under Sidot's process, and produced that specimen. The one glass contains a half of the hank simply carbonised, and the other the hank treated by Sidot's process.

Mr. CHARLES: Then you put into Sidot's process a thread already carbonised?—I did.

Just look at what M. Sidot does: "I introduce into a porcelain tube little pieces of wood, across which I begin by passing the vapour," and so on. Is not this process really a process for the carbonisation of the thread, not for the treatment of a carbonised thread?—I wanted to give it the very best chance.

You began with a carbonised thread, and then put that through Sidot's process?—Yes.

Is not the process itself a process for the carbonisation of the thread?—I do not understand so. I think that his process is applicable to charcoal, or you may carbonise it if you please in a tube. It makes no difference; it only takes a longer time. I had only to heat it more gradually, and as time was not available I carbonised it previously, and used it in that form.

Mr. MOULTON: If your lordship will look at the paper you will see Sidot uses both methods. In the latter part of his paper he speaks of wood being *chauffé au rouge* before he passes the vapour over it.

Mr. JUSTICE BUTT: That is the wood. Mr. Charles is dealing with linen, cotton, and so on.

Mr. ASTON: The first process deals with "*petites faisceaux de bois.*"

Mr. JUSTICE BUTT: Then having said that, he says, I have obtained the like substances from certain other things, and it is those other things. Linen thread is the one Prof. Dewar has operated upon.

Mr. CHARLES (to witness): What hydro-carbon did you use?—Yesterday I used benzol vapour.

Is that a very highly carbonised hydro-carbon?—Yes, it contains a very considerable quantity of carbon. He does not

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mention any hydro-carbon; he says hydro-carbons generally. Paraffin oil would have been the same thing.

Suppose you had used a hydro-carbon, such as marsh gas, would you not have got a less irregular filament than the one you did produce?—I cannot say. All I can say is, that I have tried with coal gas, which contains a very large proportion of marsh gas, and the deposit is of the same character as that described by Sidot.

Can you show me a specimen result which you obtained by coal gas?—No; but I can show you a result more remarkable. That deposit in the porcelain tube is done without the wood spirit. He describes this black growth of the filament as resulting from wood spirit, and that wood spirit contains actually 50 per cent. of oxygen.

You did not experiment on the thread with the wood spirit?—No.

(To be continued.)

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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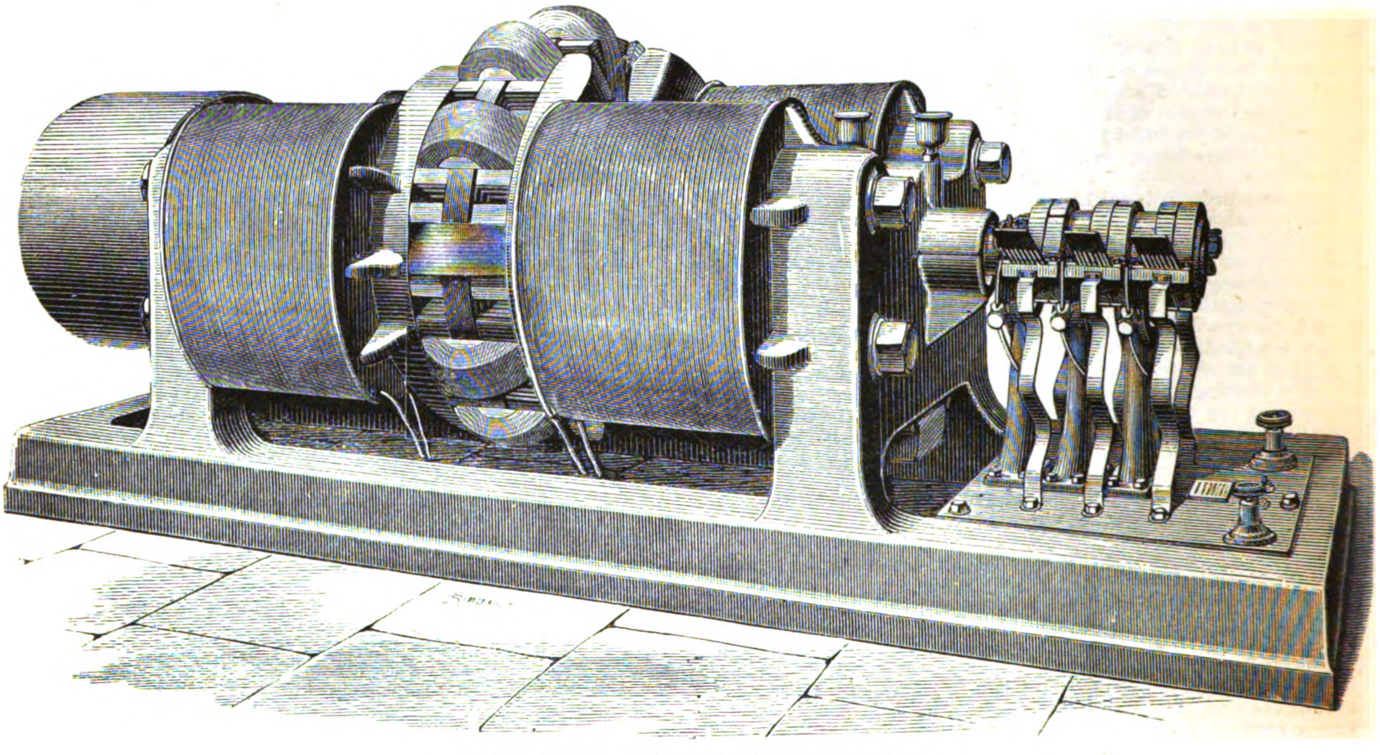
(*Continued from page* 518.)

A CASUAL glance, indeed, at the Brush machine is sufficient to indicate that so far as appearances go it has not much in common with the dynamos which I have already described to you, and I have intimated that its *modus operandi* differs from any of the foregoing. The collector is entirely different from that of Gramme or Siemens, somewhat resembling a number of Pixii or Clark commutators, in a modified form, grouped together on the end of the armature axle. I have previously said that the coils on the Brush armature do not form a continuous circuit, and, as a matter of fact, they are connected together in pairs, not consecutively, but each to that diametrically opposite it.

For each pair of coils there is a separate commutator, so that if a ring is wrapped with eight coils there are four distinct commutators, or for 12 coils six commutators, side by side upon the axle. This sketch represents the commutating arrangement employed for an armature of four pairs of coils, and although at first sight one might think there are only two, there are really four commutators corresponding to the four groups of coils; one pair of commutators being set 45° in advance of the other. The collecting brushes are so arranged as to touch at the same time the commutators of two pairs of coils, but not of two adjacent pairs, the adjacent commutators being always connected to two pairs of coils which lie at right angles to one another in the ring. By the aid of a diagram we shall be better able to understand the cycle of operations which go to effect the production of the current in the Brush machine. The thick black curved lines represent the parts of the commutators, N, S, the field magnets, and A, A′, B, B′, the collecting brushes, the connections from one side to the other being shown by the dotted lines.

Here the eight coils are, you observe, numbered as four pairs, each pair having its own commutator. To these are connected the outer ends of the wire composing each coil, and the inner ends which it is not necessary to show, are united to each other. In the actual machine each pair of coils as it passes through that part of a revolution in which there is least action, is cut out of circuit by causing the two halves of the commutator to be separated from one another by a short distance at each side. As shown to you here, the coils, 1, 1, are cut out of action, for neither of the two halves of the commutator touch the brushes. Coils 3, 3, are in the position of greatest action, and the powerful current induced in them flows out at brush A into A′. This latter is connected across to brush B, where the current re-enters the armature



A BRUSH DYNAMO WITH A 12 COIL ARMATURE.

The coils, 2, 2, have just left, and coils 4, 4, are approaching the position of greatest action, and through both pairs, therefore, partial induction is going on. The current on passing into B divides, part going through coils 2, 2, and part through 4, 4, reuniting at B′, whence the current circulates round the coils of the field-magnets to excite their magnetism, then round the external circuit—usually composed of arc lamps—and back to A. Each set of coils will therefore during rotation be brought consecutively into the position of least action and be cut out of connection; and so the cycle of operations goes on.

Whichever pair of coils is in the position of greatest action is delivering current direct into the circuit, and the two pairs which occupy the secondary position, such as 2, 2, and 4, 4, alluded to just previously, are always joined in parallel, *i.e.*, the same pair of brushes touch the respective commutators of both.

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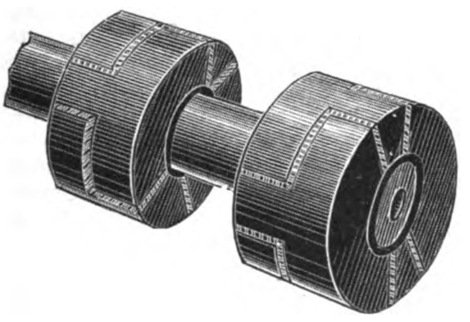
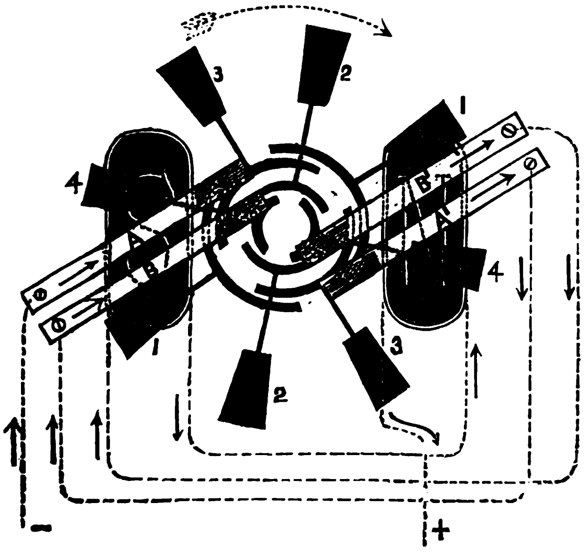
The four pairs of coils may be looked upon in the light of four separate machines delivering alternating currents to a commutator which changes them to intermittent currents in the same direction, the series being united into one ingenious system or whole.



BRUSH COMMUTATOR.

The doings of the Brush machine in this country are doubtless familiar to you. Its introduction was the signal for great advances in electric lighting, but the manner in which the system was commercially developed was productive of much evil, and, at the same time, of a little good.



CONNECTIONS OF BRUSH DYNAMO.

The next dynamo which must claim your attention is that constructed by Edison. This, in principle, will be far more easily grasped than that of which we now take our leave, for it goes much on the lines of Siemens, the principal points of interest lying in the method of coiling and construction of the armature, and in the massive field-magnets.

(*To be continued.*)

ON THE APERIODIC GALVANOMETER OF DEPREZ-D'ARSONVAL, EMPLOYED AS A BALLISTIC GALVANOMETER.

IF we seek the value of the proportion which exists between the constant deviation, α, produced by a permanent current of the intensity, i, and the impulse, δ, produced by the passage of a quantity of electricity, q, for the Deprez-d'Arsonval galvanometer, says M. Ledeboer, in *Comptes Rendus*, we are led to solve the differential equation which represents the movement of the coil. This equation may be put in the following form :

$$\frac{d^2\theta}{d\,t^2} + \frac{1}{R}\frac{\pi^4}{T^4}\frac{\alpha^2}{i^2}\,\Sigma\, m\, r^2\,\frac{d\,\theta}{d\,t} + \frac{\pi^2}{T^2}\,\theta = \frac{\pi^2}{T^2}\,\frac{\alpha}{i}\ \mathrm{I}.$$

when the galvanometer is traversed by a current of the intensity, I.

All the constants which enter into the equation, viz.:

R the total resistance of the circuit ;

$\frac{\alpha}{i}$ the constant of the galvanometer ;

$\Sigma\, m\, r^2$ momentum of inertia of the movable coil ;

T duration of a simple oscillation with open circuit ;

may be directly determined by experiment. We may, therefore, solve this equation each time that the initial conditions are given.

The kind of movement depends on the roots of the characteristic equation. When the roots are imaginary the movement is oscillatory ; but when the roots are real the galvanometer is aperiodic, and the coil displaced abruptly by the passage of the quantity of electricity, q, returns to the position of equilibrium.

We obtain simple formulæ if we consider the limited case for which the roots of the characteristic equation are equal. The total resistance of the circuit which answers to this case is given by the formula

$$R = \frac{1}{2}\,\frac{\pi^3}{T^3}\,\frac{\alpha^2}{i^2}\,\Sigma\, m\, r^2$$

To find in this case the impulse, δ, due to the passage of the quantity of electricity, q, it is necessary to solve the differential equation without the second quantity, with the initial conditions

$$t = 0\ \theta_0 = 0\ \left(\frac{d\,\theta}{d\,t}\right)_0 = \frac{\pi^2}{T^2}\,\frac{\alpha}{i}\,q$$

We thus obtain the formula

$$\delta = \frac{\alpha}{i}\,\frac{\pi}{T}\,\frac{i}{e}\,q$$

This condition is realised by the discharge of a condenser, the galvanometer being provided with a shunt such that the total resistance of the circuit is equal to R.

On removing the shunt we have an open circuit and the discharge of the same condenser, under these conditions gives place to a deviation, δ', given by the equation

$$\delta' = \frac{\alpha}{i}\,\frac{\pi}{T}\,q.$$

Which gives for the ratio of the deviations the relation

$\frac{\delta'}{\delta} = e = 2{\cdot}72$ the base of the Napierian logarithms.

The experimental verification of these formulæ has been made by the aid of two Deprez-d'Arsonval galvanometers, the one with a permanent magnet and the other with an electro-magnet. The limit of resistance thus obtained can only be observed with an approximation of 5 to 10 ohms. The following table contains the results of the experiments :

	Perm. magnet.	Electro-magnet.
Total resistance calculated ...	337 ohms.	515 ohms.
" " observed ...	337 "	523 "
Ratio observed	2·52	2·68
Theoretic ratio, e	2·72	2·72

The deviation between theory and experiment is mainly due to the inconstancy of the magnetic field. This constancy is greater in the galvanometer with the electro-magnet than in the permanent magnet.

Electric Light at Eastbourne.—The Corporation of Eastbourne proposes to light the new Town Hall, when opened, by means of the electric light. The building, which will be ready by October, is likely to be formally declared open by a member of the Royal family.

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NOTES.

Electric Lighting of Edinburgh Exhibition.—Messrs. Andrews & Co. are lighting the machinery in motion section and the Old Edinburgh Street of the exhibition with 33 powerful Andrews arc lamps, which are connected in parallel circuits to two pairs of mains, one pair carrying 16 lamps and the other 17. Each section of lamps is connected to a separate Andrews dynamo, but the main wires are arranged so that the whole of the lamps can be run from one of the machines. Throughout the department the neighbouring lamps are on alternate circuits, and are arranged to produce the best illumination of the exhibits, and each one having a current of 25 ampères there is an abundance of light. The Old Edinburgh Street is lighted with one powerful lamp, suspended from a pole above the buildings, which casts a moonlight effect into the street. The machines working these lamps are Andrews' well-known slow speed dynamos, one, a large machine, weighing 3½ tons, and capable of supplying nearly double the whole number of lamps—running at a speed of 290 revs. per minute; and the other, a 35-unit machine, running at 400 revs. per minute.

Electric Lighting of the ss. "Dynamic."—Messrs. Andrews & Co. have just completed an installation of about 100 lights on board the ss. *Dynamic*, which has been under alteration by Messrs. Workman, Clark and Co. of Belfast. The current is supplied by one of Andrews patent dynamos, running at a speed of about 500 revs. per minute. The light has been distributed throughout every portion of the ship, with the exception of the signal lamps. Two clusters (portable) of three 50-candle-power lamps each are used to light the hatches when loading or discharging cargo. The fittings throughout have been manufactured by Messrs. Andrews & Co., and are of a thoroughly substantial character, and admirably suited to their various positions. The light in the saloon is especially brilliant, and the handsome nickled fittings give it a very effective appearance. One particular which is worthy of note is the despatch with which the electrical outfit has been completed, the vessel only having been laid up for a fortnight, and the trial of the electric light having been made with the most satisfactory results the night before she left the dock.

The company has also just completed the electric lighting of the second of three magnificent Atlantic steamers for the North German Lloyd, of which we hope to give a description hereafter.

Electric Lighting at Glasgow.—The minutes of the joint sub-committee of the Glasgow New Municipal Buildings Committee and Bazaar Committee, on the question of electric lighting, of date 30th April, contained the following note :—"The meeting had before them the question of the expediency of getting one place where the motive power necessary for lighting the New Municipal Buildings and the Bazaar Buildings and City Hall by the electric light could be produced, and after full consideration, were of opinion that the Bazaar Committee should endeavour to find accommodation in the new buildings now being erected by them for the production of the necessary power for lighting the Bazaar and City Hall by means of electricity, and also such additional power as would be required for lighting the New Municipal Buildings." Mr. Filshill, convener of the committee, said that from inquiries he had made from three or four different parties, he had found that the cost for lighting the City Hall and the Bazaar with electricity would be at the outside, £3,000. After the system had been fitted up and set thoroughly in operation, the probable saving of expense would be from £100 to £150 a year. Two or three years ago the council agreed to make the tenants of the Bazaar pay for the gas which they used. The result had been most unsatisfactory. Some of the tenants did not use the gas, and the consequence was that the Bazaar was very badly lighted. Although the matter had not been formally before the Bazaar Committee, they thought that if one system of lighting was introduced, and if electric lighting was found suitable, the improvement would be very great. The yearly expense of lighting the City Hall and the Bazaar with gas was about £500, and it was thought that it could be done by the electric light for £350 or £400. A saving of £100 or £150 a year would thereby be caused. He considered it a right thing for the council to make some experiment in regard to electric lighting, and the City Hall would be a very suitable building in which to make the experiment. The City Hall was much used in the autumn when the weather was still warm, and the gas used heated the building to an almost unendurable degree. The electric light would, in a great measure, remedy this, and, with the new system of ventilation, would greatly improve the City Hall. The £3,000 he had mentioned included the lighting of the entrances of the City Hall and Bazaar, and he was assured that when once the light was fitted up, no additional outlay would be required to keep it in order. He moved the approval of the minutes of the Bazaar Committee, including the minute of the Joint Sub-Committee on Electric Lighting. Mr. James Martin seconded the approval of the minutes. In doing so, he supplemented the remarks made by Mr. Filshill by stating that the sum of £3,000 included the cost of fitting up the New Municipal Buildings with the electric light. Bailie M'Laren thought that the Bazaar Committee should consider what should be done to improve the Bazaar by fitting it up with the best appliances for lighting with gas. In many of the Government offices the electric light had been discarded in favour of the improved system of lighting with gas, and the committee ought to bring forward estimates as to the cost of lighting with electricity, and with the improved system of lighting with gas. After some discussion, the minute of the Joint Sub-Committee on Electric Lighting was delayed, and Bailie Filshill was instructed to bring forward estimates for fitting up the Bazaar and City Hall with the electric light, and with an improved system of gas lighting. Bailie Richmond thought they should get a committee of gentlemen that were not tied up with the fact that they were Gas Commissioners, a committee that would look at the question broadly, and from which a fair and impartial judgment would be got.

The Electric Light and Gas.—In Temesvar, we read, the gas company reports a fall, but not a serious fall, in the consumption of gas since the electric light was started. The number of burners has increased by 12 per cent.

Dreadful!—Bishop Turner, of the African Methodist Church of Georgia, Kentucky and Tennessee, is reported to have said recently :—"I admire the great inventions of white men, and especially in controlling electricity; but the subjection of God's agent is carried too far in making it light the world. This has already changed the meteorology of our country. Look at the floods, hurricanes, cyclones and other atmospheric disturbances taking place in the heavens and upon the earth. I predict that the unbalancing of the air currents which electric lights are causing will in a few years, if they increase in numbers as fast as in the last five years, cause whole cities to be blown away at a time, and floods unlike any save Noah's."

Electric Lighting of the Birmingham Art Gallery.—The Birmingham Town Council has decided to accept the tender of Messrs. Chamberlain and Hookham, a local firm, for the plant required for the introduction of the electric light into No. 2 Art Gallery. The gallery contains the collection of oil paintings by David Cox, presented to the town by the late Mr. J. H. Nettlefold, and one of the conditions of the bequest was that the gallery in which the paintings were placed should be lighted by electricity. The amount of the tender is £560, and the annual cost of maintenance is estimated at £100. The power will be supplied by a gas engine.

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Electric Lighting at Wentworth Castle. — The quarterly meeting of the Manchester District Institution of Gas Engineers was held last week, near Barnsley. Wentworth Castle, Stainbrough, the residence of Mr. T. F. V. Wentworth, was visited, and special attention was paid to the newly-erected machinery and apparatus by which the mansion is lighted by over 600 incandescent electric lamps.

Oriental Telephone Company's Claim for Royalty.— With reference to the claim made some time since by the Oriental Telephone Company for royalty on all telephones in use in South Australia, the Acting Postmaster-General (Mr. E. Squire) has informed us (the *South Australian Register*) that the Government have ascertained that all the telephones purchased by the local telegraph department have been manufactured under a special agreement made between Messrs. W. H. Masters and Co. and Mr. Edison, the inventor. The claim for royalty cannot therefore be enforced. Messrs. Masters & Co. would be prepared, if necessary, to protect the Government. Intimation to this effect has been given to the Oriental Telephone Company.

American Telephone Patents.—The latest developments of the Bell telephone controversy in America are as sensational as anything of which we have been before informed in the same connection. Zenas Fisk Wilber, the ex-chief examiner of patents for electrical subjects in the Patent Office, has filed another affidavit, declaring that much which he has previously sworn is false, and was extracted from him whilst he was "afflicted with and suffering from alcoholism." He is now desirous, he says, of making retribution for his past misdeeds, and of "righting a great wrong done to an innocent man." "I am convinced that by my action while Examiner of Patents Elisha Gray was deprived of proper opportunity to establish his right to the invention of the telephone ; and I now propose to tell how it was done." He then relates that he and one of Prof. Bell's patent agents had been brother officers in the Army ; that he had at various times borrowed money from this agent, notwithstanding a regulation prohibiting the borrowing of money from patent attorneys under any circumstances ; and that he was indebted to him, and under other considerable obligations to him at the time Bell's patent was applied for. He therefore felt anxious to favour him in his practice, and when he was instructed to determine, if possible, whether the application of Bell or the caveat of Gray was filed the earlier, he was desirous of finding that the Bell application was the earlier filed, and he did not make as thorough an examination as he should have done in justice to all concerned. So when he found in the "cash blotter" the entry of the receipt of Bell's fee ahead of the entry of the receipt of Gray's fee he closed the examination and determined that Bell was the earlier. After the suspension of Bell's application had been revoked Prof. Bell called upon him at the office, and he showed him the original drawing of Gray's caveat, and fully explained Gray's method of transmitting and receiving. On Bell's leaving, Wilber, by his own account, accompanied him into the hall, and there Bell presented him with a $100 bill. Prof. Bell, of course, denies the allegations made against him by Wilber, but the American papers say that there are inconsistencies in his statement now when compared with what he has previously said.

Fatal Fall from a Telegraph Pole.—Private Back, of the Royal Engineers, and a telegraph lineman, met with a shocking death at Newbury last Friday. He had walked from Marlborough inspecting the telegraph wires, and on reaching Newbury ascended a lofty telegraph pole near Northbrook Street, and was adjusting the wires when he slipped and fell, severely fracturing his skull, causing immediate death.

Cheaper Telegraphy.—It is announced that in consequence of the reduction in tariff by the cable companies, the subscription to the Anglo-American Telegraph Exchange, of 2, Copthall Chambers, is reduced to £3 3s. per month, or £30 per annum.

The Commercial Cable Company.—According to the *Electrical World*, Mr. George G. Ward, the general manager of the Commercial Cable Company, in New York, is receiving great encouragement in the fight his company is making against the "pool," and finds that the public support is both large and ready. It must be regarded as a fortunate thing for the Commercial Company, says our contemporary, that its interests here are in the hands of Mr. Ward, who is not only a faithful and careful executive officer, conversant with all the complex details of internal working, but enjoys remarkable popularity in the electrical profession and among the leading representatives of New York financial and commercial interests.

Fire Appliances at the Edinburgh Exhibition.— The different fire brigade stations within the Exhibition buildings were originally connected by means of mechanical telephones, but the working of these intruments having been found unsatisfactory, they have been superseded, at the request of the Exhibition Committee, by the National Telephone Company's system of fire alarms.

Volk's Electric Railway.—The Work's Committee reported to the last meeting of the Brighton Town Council, that they had determined to refuse permission to Mr. M. Volk for the construction of a passing place on the electric railway immediately east of the Groyne, opposite Charlotte Street. This refusal was attributed by Councillor Hall to a feeling of opposition to the electric railway altogether. The passing place which Mr. Volk proposed to construct was in a most convenient place. He reminded the Council that for the last two years the railway had carried passengers to the number of 250,000 a year, while the train mileage on the little line was 24,000 per annum. A discussion ensued, some of the speakers contending that the railway had been of benefit to the town, while others urged that it had obstructed public improvements and should be granted no further boons. Councillor Berry sarcastically remarked that he understood that Councillor Hall was one of a syndicate which was to purchase the railway, until the latter assured him to the contrary. Councillor Oliver Weston thought that Mr. Volk's "experiment" had had a fair trial, and should now be swept away altogether. Eventually the decision of the committee in refusing the application was reversed by 28 to 15.

Ryde Electric Railway.—At the annual meeting of the shareholders of the Ryde Pier Company, the directors reported that the above project had been finished at an entire cost of £1,300. The increased traffic and small working expenses justified them in congratulating the proprietors on the wisdom of their decision in adopting this mode of locomotion. Mr. George Garnett, who was largely instrumental in introducing electricity to the pier, retired from the board of directors, and he was warmly thanked by several speakers for his efforts on behalf of the company. Alderman Cudlipp remarked that Mr. Garnett, Mr. Gibbs, and himself were the trio who were bent upon introducing an electric railway—which they believed would be the future means of locomotion—into that part of the country. It had excited a great deal of interest and curiosity, indeed, he had heard an American say that they had nothing like it in the United States. A recent letter from Venice showed the directors that the fame of their new venture had travelled to the famous old city of the Adriatic.

Cricket Match.—The employees at the Manchester and Liverpool centres of the Lancashire and Cheshire Telephonic Exchange Company, played a cricket match at Liverpool on Saturday last, and after a pleasant game the visitors won, scoring 56 runs against their opponents' 40. The Liverpool team afterwards entertained the victors at dinner.

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Hopkinson's Electrical Hoist.—Our description of this invention, given last week, was taken from the *Mechanical World*, and not, as inadvertently stated, from the *Mechanical Engineer.*

Transmission of Power by Gearing.—At the Boston meeting of the American Society of Mechanical Engineers last year, Mr. Wilfrid Lewis, of Philadelphia, read a paper on "Experiments on the Transmission of Power by Gearing." These experiments which were most elaborately carried out, were made by Messrs. William Sellers & Co., and are published in the June number of the journal of the Franklin Institute. They showed conclusively the advantage of spur gearing over all other kinds in point of efficiency and durability, for not only is there less friction, and consequently less wear, but the wear in spur gearing is distributed over a great deal more surface.

The Jablochkoff and General Electricity Company, Limited.—Some inaccuracy has been pointed out to us in a note which we published last week respecting an action which Messrs. Shippey Bros. brought against the Jablochkoff and General Electricity Company for payment for certain incandescent lamps. Our note was headed "How to Elude Payment," and, from the language used by the judge, we thought this a suitable heading; but the report upon which our note was based did not sufficiently relate the facts of the case, so as to make clear that the lamps sued for were not supplied to the present Jablochkoff Company, but to a former company bearing a somewhat similar name, which went into liquidation, and which sold its business to the new company by leave of the Court of Chancery. Mention was also made of the medal awarded to the present company at the Inventions Exhibition, the award being, as was stated, for the incandescent lamps of Messrs. Shippey Bros. This statement is inaccurate, the award in fact having been for the Jablochkoff system of electric lighting.

Adelaide Jubilee Exhibition.—We have received from Sir Samuel Davenport, the South Australian Agent-General, a publication relating to the Jubilee International Exhibition, which is to be held at Adelaide next year. The age of the colony is co-eval with the reign of her Majesty, Queen Victoria, and the exhibition will be opened on June 20th, on which date her Majesty will have reigned fifty years. Active steps are being taken to ensure the success of the undertaking, a number of sectional committees having been already appointed in Adelaide, while the Government will also appoint a London commission to assist the promoters in organising the exhibition. According to the prospectus, Section B of Department III. (Education and Science) will be devoted to the exhibition of scientific and philosophical instruments and methods. Class 358 in this section will embrace: instruments of precision and apparatus of physical research, experiment and illustration, astronomical instruments, geodetic and surveying instruments, nautical astronomical instruments, levelling instruments, &c. Class 361: chronometers, astronomical clocks, electric clocks, &c. Class 362: apparatus for artificial illumination, including electric, oxyhydrogen and magnesium light. Class 363: telegraphic instruments and methods, batteries and forms of apparatus used in generating electric currents for telegraphic purposes; conductors and insulators and methods of support, marine telegraph cables; apparatus for transmission, keys, office accessories and apparatus; receiving instruments, relay magnets; local circuits; semaphoric and recording instruments; codes, signs, or signals; heliographs; printing telegraphs for special uses; electrographs; apparatus for automatic transmission; telephone, microphone, &c. Class 364: musical instruments and acoustic apparatus; phonographs, &c. Pending the appointment of a commission in London, information concerning the exhibition may be obtained through Mr. H. J. Scott, South Australian Court, Colonial and Indian Exhibition.

Military Apparatus for Electric Lighting.—An article by Captain Colson extracted from *Mémorial de l'officier du Génie*, appears in No. 11 (last month's issue) of the *Revue Internationale de L'Electricite.* The *matériel* described consists of two types of apparatus. (1) For a light of 2,500 carcels; and (2) for 600 carcels. There are numerous illustrations accompanying the paper.

The Cruto Lamp.—We are requested to state that the Cruto glow lamps are now kept in stock by the English agents, the Globe Electrical and Engineering Company, 20, Dartmouth Street, Westminster.

Railway Contracts.—Reference having been made under this heading, in a former number, to the London and North Western Railway Company's contract for electrical stores, the Globe Electrical and Engineering Company asks us to add that it has obtained the portion relating to carbon battery plates and accessories.

Perpetual Motion again!—Our New York namesake publishes, apparently quite seriously, the following:—"Among the wonders that attract the attention of the scientific public is that of the Gray dynamo-electric machine. It is claimed that tests have shown that this machine gives enough current for six 2,000-candle-power lamps for one mechanical horse-power. It is the intention of the inventor to utilise this current in suitably constructed electric motors, and thereby to obtain 4 to 5 horse-power from the motors to 1 horse-power used in driving the dynamo. A portion of the power generated by the motors is utilised in driving the dynamo, it being only necessary to start the dynamo at first by some outside force. It is expected that this system will be applied to the moving of trains, steamboats, &c."

"Father Petroleum"—Says *Invention:* "We were in hopes, when the 'Spiel' Petroleum Engine was some time ago introduced into this country, that the new invention would be actively pushed into actual use, and that it would prove a formidable enemy to the 'Otto' gas engine monopoly. As yet, unfortunately, our hopes have not been realised, and the 'Spiel' Petroleum Engine Company, which was formed to work the engine, appears to be more occupied with further promoting schemes than with the practical introduction. It appears almost as if the 'Father Brush' operations in subsidiary companies were to be repeated, only petroleum being father in this case." Then reference is made to the recent meeting of the company, reported in our last issue, after which our contemporary adds:—"As long as the engine is promptly introduced at reasonable prices, we would not begrudge the shareholders a good profit; but a different policy ought to be adopted if the primary object of the company—that of effecting the sale of a large number of engines in this country—is to be achieved."

Here is a chance for the "Etéve" petroleum motor which should not be allowed to pass.

Good Showing for a Primary Battery.—Messrs. Laing, Wharton, and Down, of London, write to the New York *Electrical Review* as follows:—"We note Dr. A. V. Garrett's speech before the National Electric Light Convention, appearing in your issue of February 27th, and, as we have an experience extending to over 2,000 lights running off primary batteries, we may feel justified in saying that it will be rather difficult for him to show better results than ours. The operating expenses are, here in London, five shillings per charge for solution for battery which will run twelve to fifteen eight candle-power lamps (Swan) for a total of 180 to 210 lamp hours the variation being due to the state of cleanliness of the batteries and proper attention to the amalgamation of zincs. To this figure about one shilling must be added for zinc consumed. This gives, you see, \$1.50 for 200 lamp hours. and we shall be glad to have a comparison of results."

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Dynamo Armatures.—We hope to publish very shortly an article on "A Comparative Study of the Performance of Armatures of Dynamo Machines." The author refutes the idea which is so prevalent, that the under portion of the coils on a ring armature is so much idle wire.

Telegraphing the Result of the Division.—Between half-past one and half-past two on Tuesday morning over seven hundred and seventy messages were despatched from the telegraph office at the House of Commons.

Electric Locomotion.—We understand that Mr. Elieson will shortly have six of his electric locomotives in operation for tramcar propulsion. We hope that nothing will be left undone to obtain accurate data of working cost, for if it can be shown beyond dispute that electrical energy comes out much cheaper than horse traction, this will do more to arouse the interest of the commercial man than any amount of writing on the subject can ever hope to accomplish.

Incandescent Lamp Patents.—What steps are the makers of incandescent lamps taking with respect to the recent judgment declaring Messrs. Woodhouse and Rawson to be infringers of the Edison patent? We hear rumours of meetings, or projected meetings to discuss the matter; but, so far, nothing definite appears to be forthcoming.

How to Wind Magnets.—The interesting series of articles written by Mr. Carl Hering, with the view of showing how to wind magnets for series, shunt, and compound machines, comes to an end in our present issue. These papers, as we have previously intimated, have been republished from the pages of the *Electrical World* of New York.

Secondary Battery Patents.—In reply to a query which appeared in our "Notes" columns last week, we have been informed that the B.T.K. secondary battery patents have just become the property of a gentleman who is also largely interested in the E.P.S. batteries. We cannot guarantee that this information is correct, but until refuted we have no reason to doubt the accuracy of our informant.

Schanschieff's Battery.—About the middle of January last, M. Criquebeuf tested a battery of eight elements in the laboratory of M. Hospitalier, and we have seen the results obtained plotted down in curves, so as to give a graphic representation of the performance of the battery. The external circuit was composed of a 10 volt Swan lamp, and a resistance of 0·1 ohm, which was used for measuring the current. The difference of potential, 11·25 volts, remained constant for a period of six hours, as did the current 0·8 ampère. At the end of eight hours the difference of potential had dropped to a little under 9 volts, and the current to 0·6 ampère.

Electric Fuzes.—The fuzes devised by MM. Scola and Ruggieri appear to show a decided advance in the direction of safety in mining operations. M. Ducretet's arrangement for testing them and ascertaining their condition is also very ingenious.

Dermatine.—This "improved substitute for gutta percha" is composed of gum, resin, turpentine, petroleum, or any spirit solvent, flower of sulphur, vegetable oil—for preference, castor oil, and oxidized calophon or other bituminous substance. This is thoroughly mixed and dissolved by heat. The inventor then mixes it with vegetable albumen or extract from lichen, previously dissolved in methylated spirit and ammonium. When the whole is thoroughly incorporated, he pours in tannic acid dissolved in aqueous solution. The whole is then boiled again, india-rubber or gutta percha added. The patent specification is dated 9th March, 1882, No. 1153.

The "Cornell" Tangent Galvanometer.—Prof. Anthony's paper on the Cornell Galvanometer, recently read before the American Institute of Electrical Engineers, serves the purpose of drawing attention to a fact of considerable importance. The indications obtained by the use of the voltameter appear to be liable to considerable variations from causes beyond control, and hence the voltameter must be used with extreme precautions. It was also pointed out that in practical operations the existing tables, even of modern date, relative to the quantity of metal deposited in a given time, were frequently found to be at variance with observed facts. If we examine this question more closely we may perhaps find a reason for these discrepancies in the fact that the tables published are not accompanied by details necessary for accurate comparison. These details ought to include the electromotive force employed, the nature of the solution, and, above all, the density of the current. Variations of these factors greatly vary the molecular nature of the metallic deposit, which naturally influences its specific gravity and thus affects the results. It would seem advisable, therefore, to conform as nearly as possible to the conditions of the experiments upon which the tables are based. Unfortunately, as stated before, these are not always to be found. Still, when we are told that experiments carried out under precisely similar conditions give discordant results, we must admit, says the *Electrical World*, that the question requires more study and further investigation.

An Improved Thomson's Little Siphon Recorder.—Mr. England, of the Mexican Telegraph Company, has forwarded to us a description and illustrations of improvements which he has effected in this instrument. We hope to publish these at a near date.

Serious Gas Explosion.—Captain Shaw, in his official report of Wednesday morning, gives the details of a serious gas explosion which occurred at 104, Inverness Terrace, Bayswater, at the private residence of Dr. H. Myriantheus, the Greek Archimandrite. An escape of gas had been noticed for some time, and suddenly a terrific explosion occurred on the second floor. Both rooms and their contents were wrecked, and the whole of the house more or less damaged, but a fire which followed was speedily subdued by the firemen, with the aid of the police and the inmates. Dr. Myriantheus was seriously burnt on the hands, face, and arms.

Transmitting and Recording Sounds by Means of Radiant Energy.—A recent patent issued to Alexander G. Bell, Chichester A. Bell and Sumner Tainter, of Washington, describes a new method for throwing a beam of light or other radiant energy into vibrations corresponding to sound waves, and also a method of producing a photographic record of such vibrations. The vibrations to be impressed upon the radiant beam are produced in liquid in motion, and this fluid impresses the vibrations upon the radiant beam. For this purpose special application is made of what are termed "sensitive jets."

Electric Locomotion in the States.—The Street Railway Committee of the Massachusetts Legislature, which visited New York, in May, is said to have been highly pleased with the motor tests it saw. Rumour has it that a report will be made in favour of an elevated electrical railway, with one row of posts, for Boston.

The Lead given to Brushes.—It is often stated on high authority that the cause of the lead which must be given to the brushes of a dynamo is due to a sluggishness in the demagnetisation of the iron core of the armature. It has been very clearly shown, however, in Professor Silvanus Thompson's "Dynamo-Electric Machinery," that the lead is not due to the cause assigned above but to the diagonal direction of the resultant magnetisation produced between the field-magnets and the armature.

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Ship Lighting.—Messrs. Henry Bennett & Co. have secured the lighting of the new passenger saloon steamer *Victoria*, launched recently from the yard of Messrs. Blackwood and Gordon, Port Glasgow. This steamer has been built to the order of Captain Campbell of Wemyss Bay, and when completed will rank as one of the finest saloon steamers on the Clyde. It is well known that there are no saloon steamers afloat to equal those which ply between Glasgow and the many watering places on the Firth of Clyde, but to Captain Campbell deserves the credit of being the first to light his steamer throughout with the electric light. We have no doubt the other steamboat owners will, in time, follow Captain Campbell's lead in this matter, and we wish the gallant captain every success in his new enterprise.

The Electric Lighting Committee.—Having held several unusually secret and exclusive sittings, the Select Committee of the House of Lords on the three Bills introduced this Session to amend the Act of 1882, have now presented a report, in which they recommend that the Bills of Lord Bury and Lord Rayleigh should not be proceeded with, but that the Government Bill which Lord Houghton brought in should be adopted, with certain amendments. These amendments are not yet obtainable, nor is the report itself yet printed, but we understand that the amended Bill does not very materially differ from the original measure.

Ships' Compasses.—The variation of the needle, says Sir Thomas Browne, "may proceed from mutations of the earth, by subterraneous fires, fumes, mineral spirits, or otherwise; which, altering the constitution of the magnetical parts in process of time, doth vary the variation of the place." Had the nobly-eloquent exploder of "vulgar errors" lived in these days, says the *Daily Telegraph*, he would have added others to his list of the causes of the deflection of the needle; and not the least strange item in the catalogue would be the wearing of electric belts by rheumatic or debilitated sailors. "One of our crew here," writes the master of a steamer at Smyrna, "has a magnetic belt. I got it from him one day last voyage, and, taking it on the bridge, I found that all three compasses were very much affected by it; in fact," adds the captain, "the highest compass of the three went reeling round and round." The moral he desires to point is that as—so at least he says—these belts are much worn by seafaring men, and firemen in particular, masters should be careful to find out what magnets their crew or passengers may happen to have with them, "either in the shape of belts or in any other form;" for, as he justly asserts, errors in the compass lead the seaman at times into terrible accidents.

Finsbury Technical College. — The students of Finsbury Technical College intend holding their second annual conversazione at the college on the evening of July 2nd.

NEW COMPANIES REGISTERED.

Kensington Court Electric Lighting Company, Limited.—Capital £10,000 in £5 shares. Objects: To generate, produce and apply electricity for purposes of lighting, heating and motive power. Signatories (with 1 share each): James Swinburne (electrician); H. J. Dowsing (electrician), 4, Queen Victoria Street; W. A. Chamen (electrical engineer), 4, Queen Victoria Street; R. E. Crompton (electrical engineer), Chelmsford; W. T. Wakeford, S. Jordan and G. R. Ryder, 11, Great George Street, S.W. Registered 5th inst., without articles of association, by Messrs. Goodhart and Medcalf, 11, Great George Street.

Bright Platinum Plating Company, Limited.—Capital £1,800 in £1 shares, with power to increase. Objects: To purchase the invention of Mr. Wm. Arthur Thoms for improvements in the deposition of platinum by means of electricity, for which provisional protection (dated 1st April, 1886, No. 4,553) has been granted. Signatories: A. E. Sarti (electrician), 108, St. Paul's Road, Canonbury, 100 shares; A. W. Herve, 152, Farringdon Road, 100 shares; H. Parminter, 27, Clement's Lane, 100 shares; F. Wingrove, 33, Aschurch Grove, Shepherd's Bush, 25 shares; H. A. Réne Moën, 38, Old Jewry, 200 shares; R. Sawford, 6, Wharton Terrace, West Kensington, 100 shares; R. Parminter, 6, Sunninghill Terrace, St. John's, S.E., 25 shares. The signatories are to appoint the first directors, qualification 100 shares. The directors will be entitled to such remuneration as may be appointed at the statutory meeting. Registered 8th inst. by Mr. G. Twynam, 35, Bucklesbury, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Woodhouse and Rawson Electric Supply Company of Great Britain, Limited.—The statutory return of this company made up to the 4th inst., was filed on the same day. The nominal capital is £100,000 in £10 shares. 2,007 shares have been taken up, and upon 7 of these the full amount has been called and paid, the remaining 2000 being considered as fully paid.

Electric Recuperative Gas Lamp Company, Limited, (Clark's Patent.)—This company was dissolved under clause 7 (4) of the Companies Act, 1886, by notice in the *London Gazette*, dated 1st June, 1886. It was registered 29th May, 1885, with a nominal capital of £27,000 in shares of £20 and £10 each, but has not carried on business, no shares having been taken up.

CITY NOTES.

United Telephone Company, Limited.—The directors have decided, subject to audit, and after making ample provision for depreciation, &c., to recommend at the forthcoming general meeting a dividend for the second half year ending April 30th last at the rate of 9s. per fully-paid share, part paid shares receiving in proportion, making with the interim dividend paid on November 13th last, a total dividend for the 12 months ending April 30th last of 13 per cent. per annum, carrying forward a substantial sum to reserve.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31st, 1886, and payable on the 24th inst. The books of the company will be closed from the 17th to the 23rd inst., both days inclusive.

West African Telegraph Company, Limited.—Application has been made to the Stock Exchange Committee for the appointment of a settling day, and the granting of a quotation for the shares of this company.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of May was 3,744, estimated to produce £3,050, against 4,474 messages, producing £3,778 in the corresponding month of last year. The receipts for the month of February, estimated at £2,750, realised £2,771.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st May are £2,988, as compared with £3,862 in the corresponding period of 1885. The February receipts, estimated at £5,034, realised £5,090.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 4th were £2,083, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for May, 1886, were £22,480; from January 1st to May 31st, 1886, £100,960; in the corresponding months, 1885, £118,000; and of 1884, £106,780.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for May amounted to £41,047 against £50,016 in the corresponding period of 1885.

The Eastern Telegraph Company, Limited. The receipts for May amounted to £50,741, against £61,327 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending June 4th amounted to £2,660.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending May 31st, were £3,450.

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NEW PATENTS—1886.

7376. "Automatic regulators for electric currents." V. NOWAK. Dated June 2.

7394. "Electrical conductors." P. M. JUSTICE. (Communicated by E. G. Acheson.) Dated June 2. (*Complete.*)

7405. "Applying electro-motors to vehicles." M. IMMISCH. Dated June 2.

7407. "Electric fuses for pyrotechnic and other purposes." A. M. CLARK. (Communicated by H. J. Smith.) Dated June 2. (*Complete.*)

7426. "Producing ferricyanides of potassium, sodium, and ammonium, by electrolysis." C. PETRI. Dated June 2. (*Complete.*)

7440. "Winding and connection of dynamo-machines with accumulators." T. PARKER. Dated June 3.

7456. "Electro-magnetic marine governor." G. A. SMITH. Dated June 3. (*Complete.*)

7463. "Electro-chemical etching process." H. E. P. DORN. Dated June 3.

7474. "Secondary batteries." W. T. WHITEMAN. (Communicated by R. J. Gülcher.) Dated June 3.

7478. "Electric lamps." S. P. THOMPSON. Dated June 3.

7479. "Turning the current on to and from incandescent electric lamps." T. MACE. (Communicated by the Vitrite and Luminoid Company.) Dated June 3.

7481. "Binders or fasteners for securing telegraph wires." J. MILNE. (Communicated by the Sydney Telegraph Department.) Dated June 3.

7544. "Dynamo-electric machines." H. J. SMITH. Dated June 4. (*Complete.*)

7548. "Testing stations for use in connection with conduits for electric wires, &c." H. H. LAKE. (Communicated by J. F. Munsie and H. N. May.) Dated June 4. (*Complete.*)

7561. "Electrode." J. and F. M. GIBSON. Dated June 5.

7576. "Dynamo-electric machinery." J. A. KINGDON. Dated June 5.

7592. "Completing and breaking electric circuits." W. H. SCOTT, E. A. PARIS. Dated June 5.

7593. "Automatically breaking electric currents." W. H. SCOTT, E. A. PARIS. Dated June 5.

7596. "Elements for secondary batteries or accumulators." J. PITKIN. Dated June 5.

7636. "Preparation or manufacture of negative elements for voltaic batteries." D. G. FITZGERALD. Dated June 7.

7669. "Electric generators." E. T. and D. HIGHAM. Dated June 8. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

4992. "Improvements in the construction and arrangement of electric lamp fittings." T. TAYLER SMITH. Dated April 22. 8d. The object of the present invention is to still further increase the range of utility of an electric lamp or lamps, and to enable one or more of such lamps to be used in a variety of useful ways, such, for example, as a hanging lamp or as a table lamp, or as a bracket lamp, the same single flexible cord serving to convey the current thereto in each case. The invention also relates to means for arresting the movement of the flexible cord in its passage through its guide when the desired length has been drawn out, and to a switch of small dimensions by which the current passing through the cord can be controlled by one hand in the act of drawing out the cord or letting it be wound up.

5627. "Improvements in apparatus for transmitting and collecting currents in electric tramways and railways." M. H. SMITH. Dated May 7. 1s. 1d. According to this invention the electric collectors or runners, instead of running upon or against the conductors as before, run under them, and are flexibly attached to the outer skid or trolly, which runs upon the surface of the road.

6313. "Improvements in apparatus for lighting gas by electricity, applicable also for other purposes where ignition by the induction of static electricity is desired." C. L. CLARKE and H. J. COATES. Dated May 23. 8d. This invention relates particularly to improvements in the construction of various parts of electric gas-lighters, wherein the ignition is obtained by means of that class of static inductive generator known as the "Voss," "Varley," and "Wimshurst" machines.

6964. "Improvements in electric batteries." G. F. REDFERN. (Communicated from abroad by J. B. Neyraud, of Lyons.) Dated June 8. 6d. Has for object to prevent the sodaic water (that is to say water saturated with a salt) at the bottom of the porous pot from rising by the capillary attraction of the porous pot to the upper part thereof, and also to prevent the head, or screw, from becoming oxydised, and by these means to attain regular working and a much greater constancy. In carrying out the invention the inventor provides a battery, the porous pot of which is provided with a porcelain or earthenware cover or head glazed at the upper part. This cover is provided with a nipple having a conical hole also glazed; this hole is stopped by a lead plug in which is fixed a screw threaded rod serving as a connection, and provided with a nut. The lead plug is traversed by a platinum wire, which also passes through a suitable insulating material, sealing the plug; the wire is connected to a piece of carbon placed in the interior of the porous pot and surrounded by small pieces of similar material; the bottom of the porous pot is formed of insulating material.

6971. "An improved system of heating by electricity." N. FRERE. (Communicated from abroad by A. Elu and E. Courcelles, both of France. Dated June 8. 8d. The object of this invention is the introduction of an improved method of converting the electric energy of a current into heat, by varying, in the direction of reduction, the sectional areas of the circuit, as well as interposing therein different metals selected for their heat conducting power.

7114. "Improved construction of Gramme armatures for electric generators and motors." G. E. DORMAN. Dated June 11. 8d. Consists in mounting the armature, or the core of the armature, on a number of narrow pulleys, partly or wholly made of non-magnetic metal, insulated from one another except at the spindle hole, strung and keyed on a shaft, and screwed together by nuts on the shaft, or bolted with insulated bolts.

7194. "Electro-hydraulic vacuum apparatus." B. J. B. MILLS. (Communicated from abroad by C. Diener and C. A. Mayrhofer, both of Vienna.) Dated June 12. 8d. This invention has for its object to provide means for working, by the aid of vacuum produced in a system of pipes, any number of apparatus, arranged at the ends of the branches of said system, and being either clocks to be wound up and controlled, or railway signalling or other apparatus. According to the invention this object is attained by means of an apparatus which, by electric or other impulsions, establishes communication between a conduit containing steam or a liquid under pressure, and an ejector, which, when acted upon by the steam or liquid under pressure, exhausts the air from the pneumatic pipes, whereupon the vacuum made exerts a second impulsion upon the apparatus, having for its consequence that the aforesaid communication is cut off again and atmospheric air is admitted into the pneumatic pipes.

7373. "Improvements in electric vibrating bells." W. R. WYNNE. Dated June 17. 6d. Consists in providing a contact lever for making and breaking the electrical circuit. This contact lever is made with projections by which it may be moved by a piece attached to the armature and is so pivotted as to remain in position until moved by the movement of the armature and the armature must move a considerable distance before it can move the contact lever. The power of the magnet is thus more effectively utilised and a longer stroke is given to the hammer.

7694. "Improvements in printing telegraphs." W. H. DAVIES. (Communicated from abroad by G. B. Scott, of Brooklyn, New York.) Dated June 23. 8d. This invention has for its object improvements in printing telegraphs, and it applies to a printer in which the step by step rotation of the type wheels is controlled by short electrical impulses alternately of positive and negative polarity.

7799. "Improvements in telegraphy and telephony." C. LANGDON-DAVIES. Dated June 26. 8d. Relates to apparatus on the Van Rysselberghe principle in which in place of condensers an instrument termed a phonopore is used, and which consists essentially of two insulated wires laid side by side and together wound upon a reel or made into a bundle in any convenient manner. One of these wires is placed in electrical communication with the transmitting key and the other is connected to earth, but by neither wire is the circuit completed. Such an arrangement when the wires are suitably insulated and arranged yields greater advantages than has heretofore been obtained by the use of condensers, and the instrument is not liable to injury by electric storms or earth currents.

8122. "Improvements in electro-telephonic transmitters." A. A. CAMPBELL SWINTON. Dated July 4. 8d. The inventor so connects the microphone proper, upon which the sound waves act, to the case or support of the instrument that vibrations communicated to the latter do not in any way affect the said microphone proper which is therefore only acted upon by the direct atmospheric sonorous vibrations. This is effected by mounting the microphone proper in a massive or ponderous frame or support of lead or other equivalent material of great inertia and high specific gravity, and in some cases by suspending the said frame or support by means of springs or bands of India-rubber or other elastic substance, or mounting it upon layers or washers of felt or other suitable non-sonorous material.

8228. "Improvements in voltaic batteries." H. I. HARRIS. Dated July 7. 8d. A wooden box six inches square by six inches deep is divided by vertical partitions into four compartments, forming four cells of equal capacity, and the inner sides of the said cells are coated with paraffin or other suitable substance in the usual way. A porous cell five and a half inches long by one and a half inches diameter, provided with a flange or foot at the bottom is placed in each wooden cell and paraffin being poured into the bottom of the cell, holds the said porous cells firmly in position, so that the battery may be inverted without affecting them. The battery is provided with a wooden cover faced with sheet India-rubber and held down by bolts and nuts or other suitable devices, and the tops of the porous pots being flush with

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the tops of the wooden cells, the various compartments and cells are effectually sealed. Four carbon rods five inches long, by three-eighths of an inch diameter are held firmly by one end in holes in the said cover and enter the porous pots, and four brass screw clips, also affixed to the cover, hold zinc cylinders two inches diameter by four inches deep, which dip into the wooden cells and surround the porous pots. The battery is charged wiuh the following ingredients; eight parts of sulphuric acid are added to eight parts of water and sodium nitrate is dissolved to saturation therein, one part of potassium bichromate is then added and the resulting solution is placed in the porous cells. The outer cells are charged with one part sulphuric acid to sixteen parts of water.

8452. "Improvements in telephonic apparatus." J. MUNRO. Dated July 13. 6d. The main object of these improvements is to provide a self-adjusting metal microphone transmitter and overcome the irregularity of working, which is a drawback to the use of metal contacts in telephone transmitters. This is done by the use of several balls, or other rolling bodies, free to roll on the electrodes between which they convey the current. The electrodes may take the form of rails or wires, with the balls, cylinders, or other rolling bodies, supported by and between them, or of plates above and below the rollers. If only one plate or electrode above or below is used, the balls or rollers should be connected together so as to roll in company.

8538. "A system of electric clock with automatic electric winding apparatus." D. VAN DE PLANCKE. Dated July 14. 8d. Relates to a system of electric regulator clocks, in which is produced an instantaneous closing and interruption of electric currents for the purpose of causing intermittent currents to pass over to different receiving dials, and at the same time to wind up the clock automatically.

8540. "Improvements in voltaic batteries." F. H. W. HIGGINS. Dated July 14. 8d. The inventor employs in voltaic batteries compound lead plates; they are formed with a series of rectangular or other perforations, which taper and are larger on the inner face of the plate than on the outer; the partitions between the perforations being reduced to a knife edge on the inner face of the plate. The perforations in the plates are filled with oxide of lead paste. The plates are fixed together face to face, and on account of the tapering form of the perforations the composition cannot escape from them—the plates are then further prepared by exposing them to the current of a battery, or of a dynamo-electric machine. These negative plates are employed in conjunction with positive plates or bars of pure zinc cast upon a wire of galvanised iron, which should extend to the end of the zinc. The zincs are amalgamated and placed within porous cells. The negative plates are on the exterior of the porous cells, and one or more may be contained in the same outer cell or vessel. The liquid made use of is such that the lead does not pass into solution.

11699. "Improvements in instruments for measuring electric currents." B. M. DRAKE and J. M. GORHAM. Dated October 1. 6d. A steelyard is first balanced in the ordinary way by sliding the weight to zero and the weight is then drawn along the scale and again balanced by the magnetic attraction of an electro magnet or solenoid round which the current, or a portion of the current to be measured, passes. The magnetic attraction is, therefore, balanced against gravity, and the scale of the steelyard gives the value of the current to be measured in ampères or volts, the winding of the wire being arranged to suit the requirements of an ammeter or voltmeter.

1886.

1160. "Improvements in smelting ores by means of electricity, and in apparatus or furnaces therefor." W. P. THOMPSON. (Communicated from abroad by A. H. Cowles of America.) Dated January 26. 8d. Consists in the improved method of operating incandescent electric furnaces, and in the combination with a furnace containing a charge of electrical resistance material, of two movable electrodes situated at opposite ends of the furnace, and projecting into the body of the charge contained within it, so that the said electrodes may, when the resistance runs down, be drawn apart, thereby increasing the amount of the charge between the electrodes, and consequently increasing the resistance, and thus preserving a uniform resistance within the furnace. The invention also consists in the arrangement of suitable mechanism actuated by the current, or a portion of the same, for automatically moving the electrodes, so as to govern the amount of energy utilised in the furnace.

1493. "Improvements in dynamo-electric machines and motors." H. J. ALLISON. (Communicated from abroad by W. L. Voelker, of America.) Dated February 2. 8d. Relates chiefly to the construction of the body of magnetic material upon which the coils of wire for the armature of the machine are wound or carried. It has heretofore been proposed to make this portion of the machine, which portion is usually of cylindrical or annular form, from a number of plates of iron put together to form the armature core or body. The object of this construction is to obtain a subdivision of the mass of iron, so as to permit more rapid changes of magnetic condition, and to prevent the flow of induced or Foucault currents in the body of iron, and to, therefore, lessen the heat developed in the armature.

2067. "Improvements in automatic electrical circuit switches particularly adapted for use with telephones." C. A. GISBORNE. (Communicated from abroad by F. N. Gisborne and D. H. Keeley, both of Canada.) Dated February 12. 8d. Relates to that class of switching which is operated in the removal of the receiving instrument from, and its restoration to, a certain place or position provided for it in the structure of the associated apparatus.

PROCEEDINGS OF SOCIETIES.

Royal Society, May 27th.

"Researches upon the Self-induction of an Electric Current." By Prof. D. E. HUGHES, F.R.S.

(*Continued from page* 530.)

In the method which I have described, the separation of the extra current from the momentary primary current is so complete that the measures given by the induction balance and resistance slide are invariably the same for a given wire; there is no personal equation, for all observers find precisely the same values both for the resistance and for the extra current.

The method is, however, defective in measuring any small difference of resistance in the variable period in copper wires, as the induction balance itself introduces an additional but opposing resistance by the approaching of its coils, consequently any resistance which we observe is a fraction less than the real amount. To prove this we have only to use a balancing induction current produced from the battery circuit, as shown in my first paper, when we observe this small difference, and better, observe any small difference of resistance in a straight copper wire, and greater when the wire is formed into a coil.

Soft iron wire gives a far higher resistance in the variable period than hard iron, but each wire, according to its molecular structure, has its own value; the effect increases with the diameter, ranging from 25 per cent. increase of resistance for wires of 2 mm. in diameter, to 500 per cent. for those of 6 cm.

TABLE II.—RESISTANCE OF IRON AND COPPER IN THE STABLE AND VARIABLE PERIODS.

Wires, 1 m. in length, 5 mm. in diameter.	Comparative force of the extra current.	Resistance in ohms, stable period.	Resistance in ohms, variable period.	Percentage of increased resistance in variable period.
Copper	78	0·001284	0·001372	7
Soft Swedish iron ...	234	0·008346	0·022200	166
American compound wire, copper exterior, steel interior	83	0·002247	0·002696	20
Ditto, steel exterior, copper interior ...	213	0·007750	0·0248000	220

Table II. shows a few illustrative examples: the resistance is given in the fractions of the ohm, indicated by the resistance slide, M, upon the supplementary resistance wire, H, I.

The table shows that copper and the American compound wire coated with copper have an extremely rapid action or curve from an infinite to its stable resistance, due to their freedom from circular magnetism, whilst iron shows a comparatively slow curve. A remarkable result will be seen where a copper wire has been coated with iron, its variable resistance being 220 per cent. above that of its stable period, and 54 per cent. greater than that of a solid iron wire.

I found in my previous researches that the resistance in the variable period could not be changed by a change in speed of a periodic or tuning fork contact maker, and that the telephone was more sensitive when the rubbing contacts were used without any regard to their frequency of interval. I also found that the telephone was far more sensitive and alone suitable for these experiments when its diaphragm was entirely free from varnish or coating, and sufficiently thick to give a clear musical dominant tone of about C or 512 double vibrations per second, the electro-magnet being also as close as possible without being in actual contact. I noticed that no matter what number of vibrations were sent, the tones given by the telephone on each side of the zero of the bridge were invariably those of its dominant note. Suspecting that the frequency of vibration of the diaphragm had a direct relation with the resistance found, I altered its note through a range of one octave by employing different thickness of diaphragms, and found that the results were in absolute proportion to the frequency of the vibrations of the diaphragm. The highest tone giving a perfect zero with a high resistance in the variable period and the low tone giving its zero at a marked less resistance. Thus it was evident that the telephone selected from the mixed vibrations sent by the transmitter those which alone corresponded to its period of vibration, and that we could thus observe the effect of more or less rapid periodic contacts.

The power which vibrating bodies have of selecting from a confused number of vibrations those in accordance with their own,

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is shown in Helmholtz's resonators, and still more as regards electrical waves in the remarkable harmonic telegraph of Elisha Gray, who proved that if the armatures of several electro-magnets are made to vibrate, each with a different musical tone or rate of vibration, then we may by the use of a vibrating transmitter of a fixed rate of speed select the electro-magnet alone whose period of vibrations is similar, and that we may send several different periods of vibrations at the same time without any confusion in the receiving magnets, as each electro-magnet selects from the compound vibrations those in accordance with its own. This is exactly what occurs with a telephone when using a periodic contact maker, but I have found in addition, that a telephone arranged as I have described, will select and respond loudly in its own clear musical dominant tone to a confused mass of rapid contacts such as those produced by a scraping contact, and which in an ordinary telephone gives only the effect of noise, of not one-third the power or loudness of that produced by the tone of the musical telephone. We may thus have ten or more telephones of different musical notes, each responding separately in their own tone or all at the same time, as each diaphragm selects its own period from the confused periods of contacts sent by the scraping contact maker.

In order to verify the results, I have used in these experiments, both periodic and mixed sound transmitters, but find that owing to the difficulty of keeping the periodic transmitter and telephone in perfect tune with each other, that the mixed sound transmitter is preferable, as it gives no trouble whatever, and we have more accurate results, as we then have only to keep our telephones in accord with the number of vibrations desired.

The experiments mentioned in this paper were all made with a fixed note of vibration of the diaphragm of 512 double vibrations per second. I will, however, mention a few made with varying rates of vibration, and as I propose in a future paper to give a more extended series of observations through a wider range, I will confine myself to these examples.

The diagram* shows the results obtained on iron wires of different diameters; their stable and variable resistance were all reduced to comparative values, the stable resistance being taken as 100. Three telephones were employed, the first having the musical note of G or 768 double vibrations, the second C sharp or 576 double vibrations, and the third, one octave below the first or G 384 double vibrations per second.

It will be seen that a great change in the variable resistance takes place in the range of a simple octave, and that the fall from the wires of 6 mm. to that of 1 mm. is so regular as to be almost a continuous curve, and the total curve would be probably that taken by the wire of 6 mm. in its approach to its stable resistance. If this is the case, as future researches may show, then the resistance of this wire with the comparatively slow contact speed of six per second would still have 14 per cent. higher resistance in the variable than in the stable period, or an ordinary Morse telegraph instrument working at a slow speed of only eleven words per minute would experience this additional resistance; consequently this effect should be easy to prove by the ordinary methods with galvanometers, and this can be accomplished as soon as we have found a method of completely separating the extra current from that due to the increased resistance, as I have already succeeded in doing by the method which I have described.

The iron wire of 6 mm. diameter shows for a speed of 384 contacts per second a comparative resistance in the variable period of 638, or more than six times its stable resistance, but with 192 contacts per second its resistance is but 371; the fall of resistance is so rapid here that for a single octave difference in the telephones, the fall is far greater than the whole stable resistance. The extra current, as well known, is proportional to the length of contact for fine wires, but in large wires the curve indicates that the extra currents have a local reaction on the cessation of the primary current.

Influence of a Magnetic Sheath.

The remarkable phenomenon wherein a non-magnetic metal such as copper shows a higher "variable" resistance when under the influence of an external coating of iron than a wire of solid iron (and this notwithstanding that the resistance of the side of the bridge is kept a constant or by balancing its resistance on the opposite side, G, D, as mentioned) seemed worthy of experimental research.

Experiments were made in order to find what form of conductor would give the maximum increased resistance in the variable period, and I found that an external tube of iron insulated from its central core produced this effect, for if the tube was not insulated but joined in electrical contact the results were reduced, due I believe to a transversal neutralisation taking place in its own portion of the wire, as I have mentioned in my reply to the discussion on my first paper.

Table III. shows the effect produced upon an electric conductor by surrounding it with an insulated sheath of iron. It will be seen that the magnetic reaction of the tube upon the primary current passing in the wire produces a marked effect upon the different metals; the force of the extra currents as measured by the induction balance rise in value from 82 to 410, this being a constant for all metals except iron, which alone shows the higher force of 615; the force of the extra currents, however, has no direct relation to the extra resistance shown in the variable period, but the latter must be in direct relation with the duration or length of time required to pass from an infinite to the stable resistance.

* See last week's REVIEW.

TABLE III.—INFLUENCE OF AN IRON TUBE UPON AN INTERIOR INSULATED WIRE.

Iron gas tube, 90 cm. in length, 10 cm. diameter, 2 mm. thick. Wires 1 metre in length, 3 mm. diameter.	Comparative force of the extra currents.	Resistance in ohms stable period.	Resistance in ohms, variable period.	Percentage of increased resistance in variable period.	Absolute increase of resistance in ohms.
Copper wire alone	82	0·00460	0·00482	7	0·00022
Copper wire insulated in the interior of the iron gas tube... ...	410	0·00460	0·03220	600	0·02760
Brass wire, ditto	410	0·01380	0·03974	188	0·02594
Iron wire, ditto ...	615	0·02944	0·05888	100	0·02944
Lead wire, ditto...	410	0·05750	0·08682	51	0·02932
German silver wire, ditto ...	410	0·07636	0·10384	36	0·02748

The table shows on comparing the resistance of a metal in its stable period with that found in the variable, that copper has the highest percentage of increased resistance, being 600 per cent. increase, or seven times that found for its stable resistance, each metal in the order of its specific resistance having a less percentage of increased resistance until we arrive at the German silver wire, which shows only 36 per cent. against the 600 per cent. of the copper; we have also here the remarkable fact that iron even with a circular section stands simply in its order of specific resistance, showing only one-sixth of the increased resistance experienced by copper; the percentage of increased resistance of a metal when under the influence of an insulated magnetic sheath is directly as its conductivity or inversely as its specific resistance.

If we regard the phenomenon from a different point of view, confining ourselves simply to the additional resistance above that of its specific stable resistance, all metals whether magnetic or non-magnetic have an almost invariable quantity dependent entirely upon the coefficient of the electro-magnetic action of the iron tube, and independent of the resistance or nature of the wire.

The experiments with an insulated iron sheath may be considered as a forced condition which does not occur or need not be taken into account, but the reaction of the iron tube is evidently electro-magnetic, and as our atmosphere is also magnetic, we may assume that its reaction would be similar though in a far less degree to that which I have shown.

Submarine Cables.

The influence of a magnetic sheath upon an external insulated wire is one of vast practical importance in relation to our electrical submarine cables, as they are all constructed with an insulated wire surrounded by a spiral sheath of exterior iron wires. In order to study this question I made several cables of short lengths (1 metre) and found (most fortunately for our practical applications) that when the exterior iron sheath is divided as in a cable, or when the sheath consists of several large wires in close contact, that its effects are reduced to a mere fraction of what it would be if the external sheath was a continuous tube; this is entirely due (as I have shown in the case of stranded wires as compared with solid) to the imperfect formation of circular magnetism. I will cite a few examples illustrating this: a cable was formed of a similar copper wire and insulation to that shown in Table III., the iron tube being replaced by eight iron wires (of 2 mm. diameter each) wound with a slight spiral of five turns per metre; this showed but 100 per cent. increase in the force of the extra currents against 400 per cent. increase when the same wire was in the iron tube; the increased resistance in the variable period was but 50 per cent. against 600 per cent. for the iron tube, or only one-twelfth of the additional resistance caused by the tubes; these wires were replaced by galvanised iron wire which prevented magnetic contact, and the variable resistance became much less, and when these were replaced by numerous fine iron wires the effect was reduced to the minimum found, or only 20 per cent. increased resistance in the variable period, or 30 times less than that of a solid iron tube of much less iron.

It is therefore evident that the circular magnetism plays an important *rôle*, and that most fortunately our cable manfacturers (without knowing the immense reaction which would be produced by a continuous sheath of iron) have constructed our cables with a protection of iron divided into several iron wires instead of a continuous iron sheath; there are, however, many telegraph lines which in passing through tunnels use a continuous iron tube as the protection, and therefore such lines must feel all the deleterious effects that I have shown to be caused by the reaction of circular magnetism.

Influence of Copper and Iron Cores upon the Induction and Resistance of Coils.

It is well known that a coil of wire has a higher self-induction than the same wire in a single loop, and that the coil has a still higher induction when we introduce an iron core. I have made, however, a series of experiments in order to measure the influence of a core upon the resistance in the variable period, and also note the influence exerted by the induced or eddy currents circulating in the core: the following table shows some comparative results:—

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TABLE IV.

Helix formed of insulated copper wire, 1·50 metre in length, 2 cm. diameter, and 24 turns.	Comparative force of the extra currents.	Resistance in ohms, stable period.	Resistance in ohms, variable period.	Percentage of increased resistance in variable period.	Absolute increase of resistance in ohms.
Helix alone ...	460	0·02632	0·02896	10	0·00264
Same with a core of solid copper ...	352	0·02632	0·04013	52	0·01381
Same with a core of insulated copper wire... ...	460	0·02632	0·02896	10	0·00264
Same with a core of solid soft iron	2338	0·02632	0·09870	275	0·07238
Same with a core of 445 separate fine iron wires, each 0·25 mm. diameter ...	5360	0·02632	0·04448	69	0·01816
Same with a core of silk-covered fine insulated iron wires ...	5820	0·02632	0·04075	55	0·01443

A helix was formulated of an insulated silk-covered copper wire of 24 single layers, having an interior diameter of 2 cm., the object being to form a coil having as little mutual induction as possible, but which would be readily acted upon by any core of metal introduced; and in order to measure the high forces obtained an induction balance of great power and range was used, the method, however, being the same as that already described.

The helix alone showed an induction value for its extra currents of 460, and a feeble increased resistance in the variable period of but 10 per cent.; if we now introduce a core of solid copper of 1·75 cm. diameter and 5 cm. long, a great change takes place both in the force of the extra currents and the resistance in the variable period, the extra currents falling in value from 460 to 352, whilst the extra resistance is increased to 52 per cent. above that of the stable period. We have here a double and contrary effect; the reduction of the force of the extra currents and the increase in the resistance cannot be due to the magnetic nature of copper, but must be due to the induced or so-called "Foucault currents" circulating in the core; to prove this the core was replaced by another similar in every respect but cut longitudinally to its centre, the currents now ceased to circulate, and the copper core had not the slightest effect either on the extra currents or the variable resistance; this is shown in the table, where for greater precautions a core of insulated copper wires replaced the solid core. Evidently the induced current in the core was the cause of the extra resistance; work was done by the primary current, and a loss of energy at the expense of the electromotive force of the extra currents, but in doing this work a resistance was produced which was no doubt caused by the currents circulating in the core. These currents required time, passing through the variable stage and thus producing from their electro-magnetic inertia an equivalent reaction and electro-magnetic inertia in the primary coil itself. That this inertia is due to the electro-magnetic character of the current and not to an electric current considered apart, is proved by the fact (which I have verified) that when we coil a wire into a coil of several superposed layers, its electro-magnetic reactions introduce a measurable resistance in the variable period precisely similar though feebler than that which would be produced by the reaction on the conductor of a magnetic body, such as iron.

The effect of a solid iron core and a bundle of iron wires on the increase of the force of the extra currents is well known, but the table shows an interesting result as to their effects on the variable resistance; the solid iron core shows a very high force of extra currents produced by its magnetic reaction on the wires of the helix. The resistance in the variable period has increased 275 per cent., and its extra currents are extremely high, as we should expect; now if the extra resistance is due to magnetic reaction alone it should increase when we are enabled to increase this reaction, but if it is due in greater part to the electro-magnetic inertia of electric currents circulating in the bar, then by preventing these currents from being formed (as we did in the case of copper) we should greatly reduce the extra resistance. This proved to be the case, for on replacing the solid iron core by a bundle of fine iron wires the force of the extra currents rose from 2,338 to 5,360, or more than double the force of that produced by a solid bar, whilst the resistance in the variable period fell from 275 to but 69 per cent.

It is well known that a bundle of fine wires magnetises quicker than a solid bar, and this may have had its effect, although not more important than the suppression of the eddy currents, as the latter may be the cause of the former. The table shows that where we have suppressed these currents as far as possible by introducing a core of insulated wires containing less iron than in the previous experiment, but fully insured against eddy currents, the induction was the highest and the resistance the lowest yet found for a helix containing an iron core; the experiment proves to my mind that the extra resistance found in the three last experiments is due both to the electro-magnetic inertia of the eddy currents, and the inertia of the magnetic molecules of iron.

The experiments related in this paper have been most carefully made and verified, and from the ease and certain action, as well as the invariable results obtained by the method which I have described, they should be easy to repeat by others.

If we regard the whole of these researches we cannot fail to notice certain important laws which act in the greater portion of them. I have shown: 1st. That the contiguous portions of the same current react upon each other in the interior of its own portion of the conductor similar to their known exterior reactions on separate portions of the same conductor. 2nd. That the coefficient of mutual induction is less in iron than copper wires, but that their coefficient is the same when the conductor is in the form of a ribbon. 3rd. That the inductive capacity of different metals depends on their specific resistance, on their electro-magnetic capacity for circular magnetism, and on the geometrical form of their conductors. 4th. That the inductive capacity of a conductor of magnetic metal is dependent upon the formation of circular magnetism, and not upon its internal magnetic permeability. 5th. That a magnetic metal can be rendered equally free from circular magnetism as the non-magnetic metals. 6th. That we have experimental evidence of electro-magnetic inertia and the deleterious effects of eddy currents in the cores of electro-magnets.

In addition to the above effects, we have the discovery of a large increase in the ohmic resistance during the variable period, allowing us to demonstrate and measure the gradual rise of an electric current in its conductor.

In conclusion, I desire to express my warmest thanks to Lord Rayleigh, Mr. F. L. Pope, Prof. Forbes, Dr. Hopkinson, Mr. W. H. Preece, Dr. Fleming, Mr. Fitzgerald, Prof. Silvanus Thompson, and Prof. Ayrton, for the important theoretical contributions they gave on the discussion of my first paper. Mr. W. H. Preece, electrician of the Post Office, not only gave information of great practical value, but has kindly supplied me with the wires used in these experiments. The discussion proved the necessity of the researches which I have undertaken, and the importance of an experimental determination of the self-induction of an electric current in relation to the nature and form of its conductor.

Abstract of a Paper read May 20th.

"On the lifting power of electro-magnets and the magnetisation of iron," by SHELFORD BIDWELL, M.A.

If an electro-magnet be excited by a gradually-increasing current, a limit is soon reached beyond which the ratio of increase of sustaining power to increase of current becomes rapidly smaller, and it has generally been assumed that this ratio continues to diminish indefinitely, so that an infinite current would not impart to a magnet much greater lifting power than that which it possesses when an approach to "saturation" is first indicated. Joule estimated that the attraction could never be as great as 200 lbs. per square inch of sectional area; and much later Rowland assigned 177 lbs. per square inch, or 14,240 grms. per square cm. as the limit for iron of good quality.

Having reason to doubt these conclusions, the author made some experiments with an iron ring cut into two equal parts, each of which was surrounded by a coil containing nearly 1,000 turns of insulated wire. When one half of the ring was used as an electro-magnet, and the other half as an armature (no current being passed through the coil of the latter), the weight supported was, with a current of 4·3 ampères, 13,100 grms.; and, with 6·2 ampères, 14,200 grms. per square cm. of surface. The lifting power, therefore, exceeded that which had previously been considered the greatest possible; nor was there any indication that a limit was being approached. But it was of greater interest to observe the effects produced when *both* portions of the ring were brought under the influence of gradually-increasing currents, the conditions then approximating to those of Rowland's experiments. It was found that when the magnetic force had reached 50 C.G.S. units, at which point the weight sustained was about 10,000 grms. per square cm., the falling off in the rate of increase of the lifting power was well marked. And it continued to diminish until the magnetic force was 250 units, and the weight supported 14,000 grms. *But from this point the magnetising current, and the weight which could be carried, increased in exactly the same proportion*, and continued to do so until the magnetic force had been carried up to 585 units, when the experiment was stopped, the maximum weight supported having been 15,905 grms. per square cm., or 229·3 lbs. per square inch. Detailed results are given in the first and second columns of the table. A curve plotted with the magnetic forces as abscissæ, and the weights lifted as ordinates, becomes, when the magnetic force is greater than 240 units, a sensibly straight line inclined to the horizontal axis.

It occurred to the author that these results might be applied to the investigation of the changes of magnetisation which correspond to changes of magnetic force. For, if W = the grms. weight supported per square cm., H = the magnetic force, and I = the magnetisation, then, for the divided ring,

$$W g = 2 \pi I^2 + H I;$$

and by giving to W and H the values found to correspond, it becomes possible to find corresponding values of H and I. These are contained in the first and third columns of the table. When H has exceeded about 200, the ratio of I to H no longer continues to diminish, and the curve expressing the relation between them apparently becomes an inclined straight line. Were the experiment carried further, a tendency to a limit would perhaps be indi-

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cated. But if there is one, it must be considerably higher than it is generally believed to be.

If κ denote the susceptibility, μ the permeability, and B the magnetic induction, then $I = \kappa H$, $\mu = 1 + 4 \pi \kappa$ and $B = \mu H$. Hence the values of κ, μ, and B corresponding to values of H can be found. They are given in the last three columns of the table. The figures for μ and B are of great interest. Rowland—in order to exhibit the results of his well-known experiments in the form of a curve which (as he believed) would be of finite dimensions—plotted the values of μ as ordinates against those of B as abscissæ. The curve of μ thus obtained, after reaching a maximum for B = 5000, fell rapidly and in an almost straight line towards the horizontal axis. Assuming that the line would continue to be straight until it actually met the axis, Rowland concluded that the maximum of magnetic induction was about 17,500 units.

Now the greatest magnetic force used in Rowland's experiments was only 64 C.G.S. units: the imaginary part of his curve, therefore, corresponds to values of H ranging from 64 to infinity. A part of this exceedingly wide gap is filled by the author's experiments, in which H reaches 585 units, and if the values of μ and B given in the table are plotted the curve will be found (after a rapid descent) to *bend round* soon after the limit of Rowland's observations, ultimately becoming (when B = 19,800) almost parallel to the axis of B.

The generally accepted ideas as to the limits of magnetisation and magnetic induction, therefore, need modification.

TABLE (ABSTRACT).

H	W	I	κ	μ	B
3·9	2,210	587	151·0	1899·1	7,390
5·7	3,460	785	128·9	1621·3	9,240
17·7	7,530	1083	61·2	770·2	13,630
30·2	9,215	1197	39·7	500·0	15,100
78	11,550	1337	17·1	216·5	16,880
208	13,810	1452	7·0	88·8	18,470
427	15,130	1504	3·5	45·3	19,330
585	15,905	1530	2·6	33·9	19,820

CORRESPONDENCE.

American Telephone Patents.

I send to the REVIEW the lastest sensation about the Bell Telephone Patent. The substance of the publication is that Mr. Wilber has made an affidavit in which he confesses that he, at that time Chief Examiner of electrical matters, in violation of the rules of the Patent Office, did show to Mr. Alex. G. Bell Gray's caveat, and that Bell gave to Wilber one hundred dollars.

Wilber has before made several affidavits respecting the issuing of Bell's patent of 1876, but this last affidavit contradicts some things in the former affidavits. Wilber explains all this in his affidavit. I send comments on this subject by the editors of the New York *Times*. I regret that I have not time to send you a synopsis of this long statement with my opinion thereon, but I shall send the latter by next steamer.

I send a newspaper containing some account of new discoveries by Bell and others. I think that St. George is ahead of Bell.

W. C. Barney.

Washington, *May 24th*, 1886.

New Patents of Bell and Others.

I send to the REVIEW two of the latest patents issued to Bell and others, and I hope you will have time (for I have not) to carefully examine those patents, especially the patent for "Recording and Reproducing Speech and other Sounds," patent issued May 4th, 1886, for which patents Nos. 6,042 and 6,047 were applied for in England on May 4th inst. in the name of the "Volta Graphophone Company."

The patentees, namely, A. G. Bell, C. A. Bell, and Sumner Tainter have procured a charter in Alexandria, Virginia (a small town some 15 miles from Washington), under the name of "The Graphophone Company," to which company these patents have been transferred (see enclosed newspaper notice). I make notice of this transfer because Prof. A. G. Bell in his testimony before the Investigating Committee of Congress, said that he had sold all his *future* inventions to Hubbard and Saunders. It has been suggested that these latest patents, although the invention of A. G. Bell, have been taken out with other names as inventors so as to avoid the effect of the sale in 1874 to Hubbard and Saunders. I desire particularly to invite your attention to the specification of an instrument "for recording and reproducing through telephonic wires articulate speech," patented by A. F. St. George, a description and drawing of which was published in the REVIEW on October 20th, 1883. I hope you will compare this great invention of St. George with that of the Bells, and perhaps you will find out that these Bells are just as much entitled to this invention as Prof. A. G. Bell is entitled to be the inventor of the speaking telephone.

I enclose an extract from the REVIEW which was taken from another paper and formed the subject of remarks by "Modesty" about St. George's invention. See REVIEW of September 15th, 1883.

A word or two about the words "*tympan, diaphragm*," I thought that the last decision by one of your "*Dogberrys*" touching the signification of those words showed an extent of scientific knowledge not possessed by any other person; but the Examiner-in-Chief of our Patent Office, C. J. Kintner, has given an official written opinion that a *hollow box of metal* is a *diaphragm* or *tympan*. It is advisable that inventors on your side of the water should know what this *scientific* Examiner considers to be a *tympan* or *diaphragm*, I refer them to a patent No. 5,001, 1882, issued in England to G. L. Anders, and I inform them that Mr. C. J. Kintner, principal Examiner in Electricity of the U.S. Patent Office, has rejected an application for a patent for a telephonic transmitter, for the reason that the *tympan*, which is a *thin piece of ferrotype*, is anticipated by the above-cited English patent because in that patent this scientific Examiner holds that a hollow box or *Indiarubber* ball is a tympan. I advise your inventors who wish to use a *tympan* in any instrument for which they might wish to obtain a patent here, to consult the English patent above named.

W. C. Barney.

Washington, *May 29th*, 1886.

[The patents to which our correspondent refers are for improvements in phonographs. We do not see any similarity between these and the patent of Mr. A. F. St. George.—EDS. ELEC. REV.]

Schanschieff's Battery.

There has been some correspondence in your columns lately on Schanschieff's batteries, and as I have tested them several times, will you kindly permit me to give you my experience of them.

The E.M.F. is about 1·4, and remains pretty constant until the solution is nearly exhausted. The zincs require no amalgamation, the battery gives off no fumes; and to give M. Schanschieff the credit justly due to his invention, I believe that his single fluid battery is the best yet produced in respect of space occupied, length of time it works, and E.M.F. The greatest objections seem to be the cost of solution, and the destruction it brings upon terminals and connections more than other solutions, but doubtless this can be remedied to a great extent.

The solution should never be used in any cell or with any elements that have worked with any other solution, or the effects of which Mr. Conry complains will follow, very much to the detriment of the battery. To get a good result, great attention should be paid to cleanliness, a fact which is quite lost sight of by the majority of people using batteries.

A Maker of Primary Batteries.

June 7th, 1886.

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The Laws of Magnetism.

Not in any captious spirit, but solely for information, may I venture to ask if it is consistent with the known principles of electricity that a compass should be found serviceable on the exterior of a revolving globe, so that let it be placed wherever it may, it should point to one spot on that spherical surface? May I hope that this question will be answered without any reference to prevailing notions?

John Hampden.

Balham, S.W.

[The magnetic action of a compass needle is in no way affected by motion being given to the compass; it is strictly consistent with the laws of magnetism (permanent or electro) that a compass needle should point towards a magnetic fixed point on a sphere when the latter is revolving.—EDS. ELEC. REV.]

Military Telegraphy.

In reference to Captain Cardew's paper read at the Telegraph Engineers on May 27th last, it may be of interest to point out that others had in 1881 turned their attention to telegraphing with the telephone. There was, in the Italian division of the French Exposition d'Electricité, exhibited a telephone made to buzz by a switch in it, and connected with it a battery, to be carried on the shoulders like a knapsack. I think the exhibit was that in the Catalogue Général Italie (Royaume D), Groupe 1, Classe 7, numbered "16C5, Racagni (Charles Félix), Colonel, et Gugliemini (Emile Antoine), Vérone-Telegraphe, télephone de campagne et application du téléphone a la télégraphie." I think the telephone had some mechanism besides the buzzer; but from the mass of electrical novelties I then saw, I cannot say that I remember sufficiently these last.

H. G. Y.

June 7th, 1886.

Long Distance Telephony.

Allow me to make a few remarks concerning the correspondence *re* Long-Distance Telephony that appears in your issue for June 4th.

My own individual experience is in direct contradiction to "Slabee's" statement that the Newcastle Post Office officials are unwilling to show their telephonic arrangements to outsiders, as some time ago I made application for myself and two others interested in telephony to see over the exchange, and, though entire strangers, no objection at all was made, and everything was shown and explained to us with the utmost readiness and courtesy.

"Telephonist" states that during the last year or so the telephone service in London has greatly improved. All I can say is that if this is the case it must have been bad, indeed, before. A sad experience of one day, a few months ago, when I tried for fully half-an-hour to communicate from Northumberland Avenue to Holborn Viaduct, and had eventually to give it up and send a telegram, as owing to the persistency and loudness of the induction noises and the weakness of the telephones, speaking was quite hopeless, makes me think that there still remains considerable room for further progress in the metropolitan telephone system. I believe, moreover, that my experience is by no means an isolated case, as I have heard of many other similar instances of failure.

I may mention for the benefit of A. Watts, "Slabee," and others, that though a constant user of the Newcastle Post Office system, I have never come across a failure of any description; and that the double-wire system employed, though entirely underground, eliminates induction noises and cross talk altogether. In fact, from my own experience, and from what I have heard from others, I have no hesitation in saying that the Newcastle Post Office exchange service is second to none in the United Kingdom.

I believe that this is very largely due to the double-wire underground system, which is not subject to the vicissitudes of wind and weather that affect overhead wires, but also in great measure to the Gower-Bell instruments that are used, which, though perhaps not absolutely quite so distinct in articulation as the Bell-Blake combination, are much louder, and with their double ear-tubes in every respect more suitable for use in offices and other noisy localities.

The Gower-Bell instruments are very substantially put together, and seem to be peculiarly free from the defect of easily getting out of order, which is more than can be said of the others.

A. A. Campbell Swinton.

Newcastle-on-Tyne,
June 7th, 1886.

I am aware that there is no manner of copyright in *Noms de plume*, still I cannot but feel just a little aggrieved that someone has borrowed that of "Telephonist," in order to sing the praises of the existing telephone companies, especially as I emphatically disagree with most of what this someone promulgates.

Permit me to subscribe myself the original

Telephonist.

June 5th, 1886.

I notice the following statement in your answer to several correspondents' letters on the above subject:—"We believe that if application is made in the proper way every facility would be given to an applicant to see the postal telephonic apparatus." Can you kindly tell me which is the proper way to make this application? For my part, as a member of a private company, I am most anxious to visit the Newcastle exchange, after all that has now been said concerning its arrangement and working. You must confess that if a certain number of people who call themselves "we who know" insist upon keeping Mr. Smith in the dark, they can, without fear of contradiction, describe him as being tall, short, ugly or handsome.

Your correspondent "Slabee" states that Mr. Preece has visited several of the private companies' exchanges, then why should members of the private companies be refused admittance to the postal telephone exchanges? Until this state of things is altered the improvements made by postal telegraph engineers must, as far as we (who are not numbered amongst the "knowing few") are concerned, remain a myth. Vast improvements are no doubt required to make telephony what it ought to be, and I certainly think that the more the members of the opposition parties know of each others ideas on the subject, the more likely are the public to benefit by real improvements; and not be told, as at present they are in the Tyneside district, that they have improvements as near perfection as possible in daily use; and when they ask, "What are they?" receive the answer, "Oh, you must leave that to us! 'we who know' say they exist, and therefore it must be true."

I was greatly surprised to see that you referred "Telephonist" to a number of *Punch*, after stating that "you do not expect to see aught but blundering when the *Times* takes in hand anything electrical." What do you expect to see but the ridiculous when *Punch* does so? As a settlement of this somewhat bad-tempered discussion, I should suggest that the Mr. Smith in question be put through his paces in broad daylight, and, perchance, he may turn out to be as perfect a being as described, and then "we who will know" will assuredly give credit where credit is due.

Carnwath.

June 8th, 1886.

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VOL. XVIII.—No. 447.

THE ELECTRIC LIGHTING ACT.

WE doubt very much if those who have so long been agitating for a change in the law relating to electric lighting will cry content with the amended Bill of Lord Houghton which the "Secret Commission" of the House of Lords has just recommended to Parliament. In another column we publish the full text of the Bill, together with a brief sketch of its history. It will be seen that the most important clause is that which gives the Board of Trade power to vary the conditions of purchase upon which local authorities can, under the 27th section of the existing Act, acquire an electric light undertaking. In the original Bill brought forward by Lord Houghton, the section giving the local authorities power at the end of twenty-one years to purchase compulsorily at the price of the material only, and without any addition by way of compensation or for goodwill, remained intact. Various suggestions have been made for the amendment of this provision, many persons seeming to suppose that an extension of the period at which the local authority might step in would meet the case. The longer the undertakers are allowed to work without interruption, the more favourable, of course, will be their prospects of success; but to our mind the very principle of compulsory acquisition upon such terms is wrong, and the electric lighting companies and firms should not stop until they have obtained something more definite than the discretionary power granted to the Board of Trade by the terms of the amended Bill. According to our reading of the added clause, the Board of Trade will only exercise its power in cases where the undertakers and the local authority have already agreed as to conditions; and we can scarcely conceive the latter, with the right of acquisition open to it, voluntarily surrendering that right in order to meet the views of the undertakers. Until it does surrender its right and agree to a compromise, the Board of Trade, according to our view, has no power to interfere; and thus what is put forward as a valuable peace-offering turns to ashes in the mouth of the recipient. The solution of the difficulty has not yet been reached, and the work of Lord Thurlow's committee is still far from complete.

An engineering contemporary which formerly was amongst the foremost in opposing the Electric Lighting Act, and in contending that it retarded the industry it was meant to assist, has recently shown a complete and remarkable change of front, concluding at length that the success or failure of the electric light in the future turns not on legislation but on cost. Speaking of the failures which have taken place and the companies which have been wrecked, our contemporary says: "It is easy to say that their arrangements were not perfect and that money was wasted. All that is quite true. But if money had not been wasted and the arrangements had been as perfect as possible, the result would have been the same." Now, eighteen months or more ago we had something to say upon this question of amending the Electric Lighting Act, and the words we then wrote will perhaps bear repetition now, for they are not one whit less applicable, and will also serve to show that in 1884 we arrived at the conclusion which the *Engineer* has only just reached. On November 29th, 1884, we said: "We have never been amongst those who contended that the Electric Lighting Act was responsible for the whole, or even more than a small portion, of the disaster which has overtaken the greater number of electric lighting companies. Had the Act never come into existence at all, the probability is that all those companies which have passed into liquidation would have been in precisely the same condition ere this, involving, though, a greater amount of loss." One month later, December 29th, we wrote: "Before insisting so strongly that a modification of the Electric Lighting Act would remedy the whole of the evil and lead to a general use of the light, we would advise contractors to assure themselves that the thing is possible at the present moment under legislation of the most favourable kind. That amendment or repeal of the [27th] clause would leave them with much greater freedom to push the industry to greater possibilities of success we admit and contend; but we deprecate the attempt to lay the whole of the blame for the present state of things upon the Electric Lighting Act."

This was our view in 1884, and we endorse every word we then wrote. Leaving the Electric Lighting Act altogether out of consideration, there remains a very great deal for the electrical engineer to do before electric lighting can be said to be a complete practical and financial success. How the nearest possible approach to perfection is to be reached is for those who are actually engaged in the work to ascertain; but that success will ultimately attend their efforts we are convinced. Our contemporary to whose remarks we have already alluded, takes a much less hopeful view, and lays it down as incontrovertible that electricity cannot compete with gas in cost, and that unless it can be made so to compete it cannot be made to pay. We do not agree with this, nor with the further statement that the only chance of reduction in cost which electricity has lies in its extended adoption. Extensive use is no doubt a very desirable element; but the principal sources of reduction in cost of electricity will, we imagine, be the reduction in the cost of motive power and a still greater economy in incandescent lamps. Meanwhile, the public are gradually becoming educated to a desire for "more light," and a remunerative business is even now being done in supplying the wants of those who are willing to pay a larger sum than they have been accustomed to pay for gas, in order that they may have a better and a purer light.

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COMPARATIVE STUDY OF THE PERFORMANCE OF THE RING ARMATURES OF DYNAMO MACHINES.

THE effectual length of wire of the wrapping of the armature in dynamo machines, states F. Uppenborn in *Centralblatt für Elecktrotechnik*, has been for a long time the subject of manifold speculations and trials, more or less to the purpose. We will, in the first place, bring forward certain opinions on this subject and discuss them afterwards.

As regards the armatures of dynamos a distinction is frequently made between efficient and inefficient wire. Efficient wire is that which is carried between the polar surfaces of the magnets and of the ring, and inefficient wire is that which undergoes no inductive action. According to the common view the proportion of the length of induced wire to the total length of wire should be as great as possible. An electrotechnical fabie has, further, invested the non-induced wire with especial vices; it is said to possess a very remarkable power of developing heat which does not pertain to the induced wires. Both these wires are very widely extended and the former is still uncontested whilst the latter, though still advocated, sways only a limited number of adherents. In the following we shall refute the first opinion. The second is scarcely in need of refutation.

The actions of magnetic force ensue, as is well known, in the form of closed curves. Hereby they are distinguished from the actions of electrostatic force which are otherwise analogous in many respects. The magnetic curves are known as lines of force, or induction curves. These lines of force owe their existence to a power or form of energy which may be known as the magneto-motive power, just as the current lines owe their existence to an electromotive force.

If we continue the comparison we find that in the magnet the polar intensity corresponds to that which in the source of a current is the tension at the terminals. The circumstance that in a prismatic bar magnet the lines of force issue not only at the end surfaces but also at the lateral boundary planes is explained by the fact that the bar magnet is surrounded on all sides with a fairly good conducting medium, the ether, which is in general not the case with sources of currents. The intensity of the poles decreases the more the better the external closing, in so far as such closing is continuous and commences directly at the polar surfaces. Nevertheless in this case the number of the lines of force of the magnetic circuit increases. The above conditions would occur in practice if the poles are connected by a piece of iron of a suitable shape.

The result is different if a small interval is left between the poles and the external iron conduction; in this case not only the number of the lines of force but the polar intensity will increase. This is the arrangement in ordinary dynamo machines. The ring in such machines is wrapped with wires in such a direction that the wires are cut as far as possible at right angles by the lines of force issuing from the poles. In the arrangement now most prevalent, where the copper coiling forms the interval between the polar surfaces of the electro-magnets and those of the ring, the wrapping must be carried at right angles to the direction of movement of the wires. In such a dynamo with only two poles the same process of induction occurs in both halves of the ring. Both halves of the wrapping are introduced parallel, so that both the current intensities, though not the electromotive forces, are added together. The electromotive force of the ring is the greater the greater the number of the lines of force which enter it from the poles or which take the converse direction. We may put $E = c\,m$, c being a constant and m denoting the number of the lines of force. E will also be proportional to the number of intersections which the conductor undergoes from the lines of force during a certain movement. In an ordinary two-pole machine we may then assume with certainty that any given spiral must have intersected all the lines of force when the ring is turned round 180°.

The electromotive force depends, therefore, on the number of coils which are carried past a pole of the machine in a unit of time. If we take *e.g.* the semi-revolution of a two-pole machine, E will be proportional to half the number of coils. The coincidence is, however, only accidental and can easily give rise to misunderstandings if we apply the same considerations to multipolar machines. If we take a ring exposed to the action of two poles, and therefore halved, and resolve it into four parts by means of two additional poles, we might be readily inclined to assume that since each of the four parts now possesses only half as many coils as did each of the halves previously, the electromotive force of each part is only half as great as formerly; this, however, is a deception. The number of coils which move past one pole of the machine in a given time is not affected by the application of two additional poles. The electromotive force, therefore, remains the same. It is no small advantage of the multipolar machines that by their means it is possible, at the same speed and with the same heating of the ring to obtain a double or a manifold effect. This

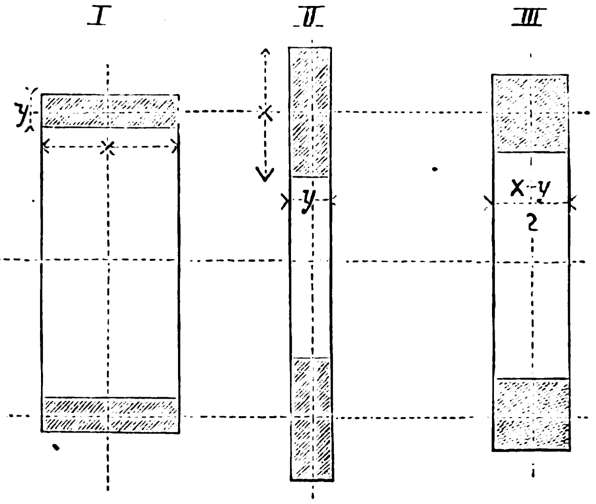


FIG. 1.

increased utilisation of a ring has, of course, a limit which cannot be exceeded without other sources of loss compensating, or even outweighing, the advantage aimed at.

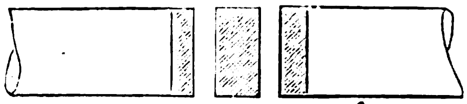


FIG. 2.

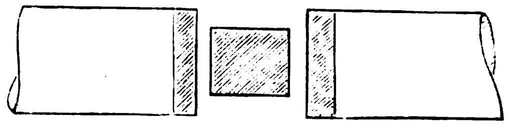


FIG. 3.

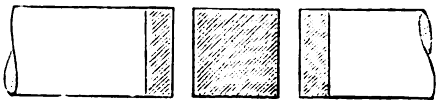


FIG. 4.

If the mean speed of the bobbins, length of wire and number of coils remain the same, that ring will naturally be preferable which developes the greatest electromotive force. But the number of lines of force, as we have already seen, increases with the mass of iron in the ring. Hence the preference must belong

to that shape of ring which permits the application of a maximum of iron.

Let us apply this to the construction of ring armatures. In fig. 1 I. represents a cylindrical ring, II. a flat ring, and III. a square ring. The three centres of gravity of the sections lie at the same distance from the axis of rotation. The circumferences of the three sections are alike. If we now suppose an equal number of equal bobbins applied on each ring, the number of coils, the length of wire and the resistances of the three rings are alike. But the square ring has the advantage of containing most iron. If we call the respective sections of the iron f_1, f_2, f_3, we have the following relations :—

$\frac{x}{y}$	Cylinder ring.	Flat ring.
1	$f_1 = f_3$	$f_2 = f_3$
3/2	$f_1 = 0·96 f_3$	$f_2 = 0·96 f_3$
2	$f_1 = 0·91 f_3$	$f_2 = 0·91 f_3$
3	$f_1 = 0·75 f_3$	$f_2 = 0·75 f_3$
4	$f_1 = 0·64 f_3$	$f_2 = 0·64 f_3$
9	$f_1 = 0·36 f_3$	$f_2 = 0·36 f_3$
99	$f_1 = 0·04 f_3$	$f_2 = 0·04 f_3$

It is evident that the square ring is by far the most advantageous as regards the iron section. It especially exceeds the cylinder ring in which the ratio $\frac{x}{y}$ has a high value. In Gramme machines we have the $\frac{x}{y} = 6$; the section of the iron being only half the section of the square ring. Flat rings are not generally constructed in such abnormal proportions and the position of affairs is not quite so unfavourable. Besides, in the flat ring the diameter of the core of the magnet decides the breadth of the pole pieces, so that it would be disadvantageous to change the flat ring (fig. 2) for the square ring (fig. 3).

Here the relations for the transit of the lines from the pole pieces to the core of the ring would become decidedly less favourable. On the contrary, it would certainly be advantageous to convert the flat ring, fig. 2, into the square ring, fig. 4. The length of wire would be increased only by one-third, whilst the section of the iron would be doubled. If the circumstances were in other respects not too unfavourable, the electromotive force of the machine would be increased by more than one-third. The result of the former considerations is therefore unchanged and the square ring must be preferred to the flat ring.

If, however, we were at once to decide on the capability of the cylindrical ring from the above table, we might easily be led to estimate it too low. On the square ring, and still more on the flat ring, there remains space which is not utilised. In the wrapping there are formed wedge-shaped interstices. This loss in the cylinder ring is practically non-existent. A cylinder ring of equal iron section and equal $\frac{x}{y}$ may have a decidedly smaller diameter by which its magnetic resistance is reduced to a corresponding extent. It might therefore seem as if the cylinder ring were preferable to the flat ring. But for deciding on the merit of both forms the following consideration must be kept in view. A very essential part of the magnetic resistance consists of the resistance of the intervening stratum (filled with air and conductive matter) which separates the polar surfaces of the electro-magnets from those of the ring. The section of this stratum is double as large in a flat ring machine as in a cylinder ring machine. Hence the magnetic resistance of this stratum in the flat ring machine is about half that of the cylinder ring machine. Hereby the above-mentioned advantage of the cylinder ring machine is not merely compensated but outweighed. The above considerations do not, therefore, show that the cylinder ring machine is more effective than the flat ring machine.

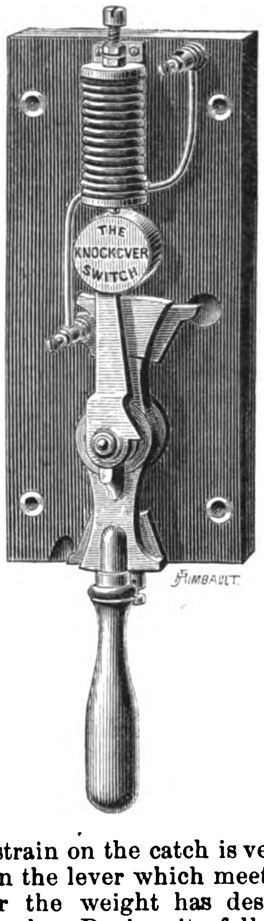
In the foregoing, the relation of the length of induced wire to the total length has not been referred to. In the square ring this proportion is 0·5 ; in a flat ring about 0·75. It is therefore simply perversity to maintain that this proportion must be very great.

The case is similar with drum machines. If that machine were best in which the above proportion = 1, drum machines would be built very long and of small diameter. This plan, however, has long been superseded and the drum rings are now made short and thick. An exception is allowed only in very large machines in which very large sections of iron do not become equally magnetised.

THE "KNOCK-OVER" SWITCH.

THE "knock-over" switch (Goolden-Trotter patent) is an ordinary double-break switch, provided with a device for automatically breaking the circuit when the current or the volts exceed a certain fixed quantity. The switch is fitted with an ordinary handle, and has large solid contact surfaces and sparking pieces.

The breaking of the circuit is effected automatically by a "knock-over," which consists of a weight at the end of a lever, pivotted upon the axis of the switch. The centre of gravity of the weight is nearly over the axis, having a slight tendency to fall, and is held in this position by a catch at the end of the core of a



solenoid. The strain on the catch is very small. There is a projection on the lever which meets with a stop on the switch after the weight has descended through about a right angle. During its fall, it acquires considerable momentum, and comes into collision with the switch with more than sufficient force to knock it over. The solenoid can be wound for high or low resistance ; and can be adjusted for any required volts or ampères, either by a spring or by weights.

By regular use as an ordinary switch, freedom of action is ensured. When the switch is "off" under ordinary circumstances, the "knock-over" is still retained by the catch, so that it can be seen at a glance whether the current has been broken automatically or as a cut-out. We have ourselves examined this switch, and find that its action is satisfactory ; but an appreciable period elapses during the fall of the weight.

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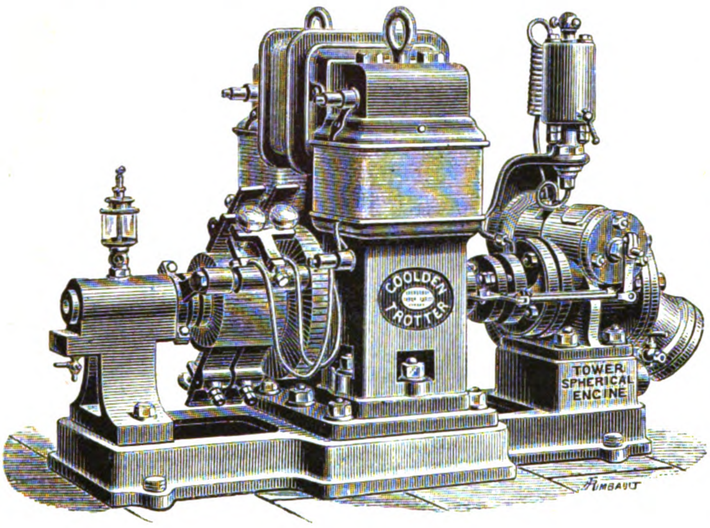
GOOLDEN AND TROTTER DYNAMO.

IT is not often that three independent individuals hit upon the same idea almost simultaneously. A new type of dynamo, so far as the arrangement of the magnets is concerned, has been introduced by Messrs. Goolden and Trotter, a very similar pattern having been recently produced by Mr. Kapp, and it appears that an American inventor is working on the same lines.

The dynamo may be described as having an Edison field in which the yoke as well as the side bars are wound. A number of these dynamos have been mounted with Messrs. Heenan and Froude's Tower spherical engine for use on the sea-going torpedo boats, the combination being probably the smallest for its weight, speed and out-put that has ever been produced.

The dimensions over all are:—height, 2 feet 3 inches; length, 3 feet 6 inches; width, 1 foot 6 inches; weight,



with bed-plate, lubricators, &c., 8 cwt. The out-put is 60 ampères, 60 volts, at 650 revolutions, and at 90 lbs. steam. The engine and dynamo are easily able to produce 4,000 watts at 700 revolutions.

The dynamos for H.M.S. *Severn* and *Mersey* are larger examples of the same pattern. Messrs. Goolden and Trotter continue to make the Gramme type of dynamo (with which their name is associated) when extreme compactness is not required.

VISIT TO SILVERTOWN.

BY invitation of the directors of the India-Rubber, Gutta Percha, and Telegraph Works Company, on the occasion of the presence in London of representatives from the Colonies and India, a party of about two hundred ladies and gentlemen visited the company's works at Silvertown, on Thursday, the 10th inst.

The party started from the Temple Pier in a specially chartered steamer, and proceeded down the river to North Woolwich, where a special train was in waiting to convey the visitors to Silvertown.

With a view to call the attention of the guests to the various objects of interest met with on the trip down the river, a small guide-book had been handed to each, indicating these points and containing also a general description of the works at Silvertown.

On arrival at the works the visitors were formed into parties conducted by members of the company's staff, and no time was lost in commencing the inspection of the various workshops. Owing to the manufactures being of so varied a character, the time at disposal so limited, and as the works cover 15 acres of ground with a floor area of about 10 acres, it was hardly to be expected that a very detailed inspection could be made, and many departments were therefore left unvisited.

In the first building inspected was seen the percha in its raw state, that is as received from the East Indian Islands and the Malay Peninsula, whence the gum is principally obtained. Here also the various cleaning processes were shown. These are operations of considerable importance when it is considered that from 25 to 30 per cent. of impurities, chiefly sand and bark, have to be removed.

The first process of cleaning consists in cutting the lumps of gum, when too large, into small pieces, and boiling them in steam-heated tanks. During this operation a large proportion of the sand and of other impurities of a higher specific gravity than percha (which itself is slightly lighter than water) is got rid of.

The gum is then skimmed off the boiling tanks and is placed in the washing machines where it is further cleaned through being thoroughly kneaded by a fluted cylinder revolving in boiling water.

From these washing machines the gum is taken to masticators, where it is worked under considerable pressure and heat in order to expel the occluded moisture. The gum is then removed to the hydraulic presses, where at a pressure of about a ton to the square inch, it is forced through a series of fine wire sieves, the finest having 8,100 holes to the square inch. These sieves remove the specifically lighter impurities which the previous operations have failed to extract. For the manufacture of insulated telegraph wire and for many other applications of gutta percha, it is so necessary to have the gum absolutely free from impurities, that the foregoing operations have frequently to be repeated three or four times.

When the gutta percha is sufficiently cleansed, it is again masticated and rolled through calenders into sheets of about half an inch thick and three feet wide. In this form it is stored until required. In this workshop is also made what is called gutta percha tissue used for hospital purposes, of an exceedingly fine texture, and worth approximately about thirteen shillings per pound weight.

In passing from this building to the wire-stranding floors, the visitors were shown the large engines which supply the motive power to the washing machinery, and also the pumping engine which raises water for feeding the 31 boilers in different parts of the factory, from a well over 500 feet deep.

The water raised from this well is purified by the Porter-Clark system, thus avoiding any deleterious deposit in the boilers.

The copper wire which forms the conductor of insulated telegraph wire, which is commonly called core, is received from the wire drawers in irregular hanks or bundles; on the wire stranding floors these hanks are unrolled and the wire is straightened and coiled on bobbins. These bobbins when filled are taken to the stranding machines where they are laid up, in any number desired, in the form of one conductor, each wire having previously received a coating of adhesive compound.

The copper wire thus stranded in the form of conductors is coiled on carrying drums and taken to the covering floors. Here the conductors are hauled off the drums and drawn through the dies of the gutta percha covering machines. These dies are fed with gutta percha in a plastic state at a high and uniform pressure, and the conductors passing through the dies receive a coating of gum more or less thick according to the adjustment of the machines. The conductors thus covered pass four or five times through troughs, about 180 feet long, containing water, kept at a low temperature by refrigerating machines, in order to harden the gutta percha covering. It is usual to repeat the operation of covering three times for submarine cables and twice for underground lines. Between each operation the covering is thoroughly examined by experienced workmen, and submitted to electrical testing. This department can produce about 40 nautical miles of gutta percha core every 12 hours.

The visitors then inspected the moulding of various articles and the making of bosses for spinning machinery from gutta percha.

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After passing through the electricians' room, where the copper wire used for the conductors is carefully tested, a visit was made to the temperature tank house, where the core coming from the covering floors is subjected to a temperature, in water, of 75° Fahr., and exhaustive tests made as to the electrical condition of the gutta percha.

From the tank house the visitors were conducted to the upper and lower cable shops, passing the engineers', the fitters', the blacksmiths' and carpenters' shops, where about 150 men are employed, and where the planing and drilling machines, turning lathes, wood cutting and morticing machines, and steam hammers were seen at work. The cable testing rooms were also visited, and the electrometers, galvanometers, and other electrical instruments were explained. In the lower cable shop four heavy machines were at work engaged in the manufacture of the shore ends and intermediate types of the West African Telegraph Company's cables. In the upper cable shop the manufacture of the light intermediates and deep sea types was shown.

The core as brought on drums from the tank house is placed behind the cable sheathing machines, and after receiving a serving of yarn passes through the centre of a large disc which holds the necessary number of bobbins filled with iron wire. The disc revolving as the core passes through lays the iron wire helically round the core. The cable thus sheathed receives alternate coatings of compound and tape, or yarn, and is coiled into one of the 16 large iron tanks, for storage until required for shipment.

The cable factory can turn out about 26 nautical miles every 12 hours.

Latterly more attention has been paid to the chemical composition of the bottom of sea, and to its destructive effects on some of the older types of cable; it has been found necessary in certain cases to protect each wire of the iron sheathing with a special compound and tape. For this purpose there are at Silvertown between 70 and 80 wire taping machines, which can turn out about 280 nautical miles of taped and compounded sheathing wire every 12 hours. The tanks for storing the cable in the factory have sufficient capacity for about 3,000 nautical miles of cable. The weights of different types of submarine cable vary from the heavy shore end of 20 tons per nautical mile, to light torpedo cable of about 15 cwt.

The cable stores were next visited, and the various types of grappling and buoy ropes, the different grapnels for holding, cutting, tripping, and automatic signalling were seen, as well as the wire sounding machines, weight detachers, specimen tubes, water tubes, and deep-sea registering thermometers. The system of landing shore ends by means of balloon buoys was explained, and the buoy detachment shown in action. The visitors then proceeded on board the ss. *Silvertown*, into whose tanks the West African cable was being coiled. To show the advantage of large cable tanks such as this ship carries, we may mention that over 120 nautical miles has been coiled into one tank during 24 hours. These large tanks are still more advantageous for the paying out of cable; the *Silvertown* on one occasion having a long stretch of good bottom, was able to lay 219 nautical miles in 24 hours. These tanks are three in number, and are 53 feet in diameter and 32 feet deep. They have carried 2,400 nautical miles of cable, representing 4,900 tons; the total cargo, however, including coals and stores, was on this occasion 7,600 tons.

The *Silvertown* is the largest cable ship afloat, but is closely followed by the *Faraday*, owned by Messrs. Siemens Brothers.

The manner in which the picking up and paying out machinery is employed was then explained. The former is of a very powerful description, and for the convenience of working has two drums which can be thrown in and out of gear with the picking up engine, as may be desired. It was originally designed by the late Prof. Fleeming Jenkin, but has since been modified in certain details by the Silvertown Company. The paying out machinery is of the usual type, except that it has a powerful engine attached which is found serviceable in many ways. The dynamometers are of the usual vertical type. In connection with the paying out gear there are indicators for measuring the length of cable paid out, and a strophometer for registering the speed of rotation of the paying out drum.

On the taffrail is placed a wire sounding machine, geared to a small rotary engine, and always kept ready for immediate use.

The vessel is fitted with incandescent lights between decks fore and aft, and for deck work she carries three movable arc lamps. Her usual crew numbers about 200 men, including some 40 engineers, electricians and officers. When fully loaded she averages 10½ knots on a coal consumption of about 30 tons per 24 hours. She has a coal capacity of about 2,100 tons.

While the guests were passing between the ship and shore several torpedo experiments were carried out, among which the most noticeable was the throwing up of a large column of water to a height of 70 or 80 feet.

Before proceeding to lunch the manufacture of electric lighting conductors was witnessed. Amongst the various types the most remarkable was a conductor of which the copper alone weighed about 10 tons to the statute mile, and which was manufactured for a French company.

In the same building, but on another floor, there were seen at work the braiding machines, about 60 in number. These machines are employed in covering the small conductors used for domestic electric bell work, and for covering military field telegraph wire.

On another floor in this building the visitors were shown the manufacture of India-rubber covered wire used in places where the employment of gutta percha covered wire would be unadvisable. The vulcanisation or casing of this rubber-covered wire was explained during the visit to the India-rubber departments.

The visitors were then entertained at lunch in one of the factory buildings.

They were afterwards conducted to the battery shop where the manufacture of the various types of batteries was shown, the most important article in this branch being the Léclanché batteries, of which the Silvertown Company is the sole licensee for Great Britain and the Colonies, and of which large numbers are turned out every day. Here were also seen the large batteries used on board men-of-war for firing broadsides, as well as smaller types for torpedo work. In connection with the subject of batteries the visitors were shown the manufacture of carbon plates and of depolarising agglomerate blocks. In the same shop is carried on the manufacture of carbon rods for electric lighting, which vary in diameter from one-sixteenth of an inch to an inch-and-a-half, according to the purposes for which they are required.

The electric lighting department was then visited. On the ground floor are mounted the various dynamos and other plant necessary for lighting up the factory and for experimental purposes. For the ordinary lighting 10 double-disc dynamos of the Silvertown pattern are employed, and two others are kept in reserve. These machines serve 137 arc lamps, each of 2,000 candle-power, placed inside the various buildings, and 10 arc lamps, each of 3,000 candle-power, employed in the illumination of the roads and streets in the works. Besides the 137 arc lamps used for general internal purposes, a system of incandescent lighting is being gradually established where it is locally necessary, such as at lathes, at workmen's benches, and at certain parts of machinery. The present number of incandescent lamps in use is about 900, and it is intended to increase this number to 1,200 or 1,500.

Among the advantages of electric lighting are a larger quantity of light and a purer atmosphere. These enable the work to be carried on under more satisfactory conditions both as to quality and quantity. It is also estimated that without allowing for the in-

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creased quantity of light, a saving of from 16 to 17 per cent. is effected. In order to avoid risk of fire, the electric light conductors are covered throughout with insulating material, and the greater portion are laid underground in concrete trenches.

On the same floor was seen the switch board and circuit testing room, from which the various circuits radiate. While here, several tests and experiments were made, to show the power of the dynamo machines, the most striking being the fusing of a steel wire about 15 inches long and $\frac{1}{4}$ inch diameter, by the current from an incandescent lighting dynamo. On this floor was also seen the manufacture of the arc lamps, and of certain portions of the dynamos, the rest of the work on these machines having been already seen in the engineers' and fitters' shops.

On the next floor the visitors were shown through the electric lighting drawing office where various designs for lamps and dynamos were inspected, and were then taken to the electricians' testing room, where the different instruments, such as galvanometers, ampèremeters, voltmeters, and electro-dynamometers, were explained. The large photometer for measuring the comparative powers of different lights was shown and described, as well as the manner of fitting and finally adjusting the arc lamps.

The torpedo shop was next examined, and some experiments were carried out showing how submarine mines are employed for offensive and defensive purposes. There were noticed the arc firing apparatus, the shutter indicator, the large gun cotton cases, the circuit-closer cases, the magneto and frictional exploders, the disconnectors, and a number of other interesting appliances used in torpedo warfare, among them being the holophotes, with lenses and powerful reflectors, used with electric lamps as search lights on board ship and in forts for discovering the approach of an enemy.

As a demonstration of the transmission of power by electricity, though the experiment was of no practical value, a series of secondary or storage batteries (previously charged from a dynamo machine) actuated an electro-motor, which drove a dynamo, and this in its turn supplied sufficient current for electric lighting.

A visit was then paid to the instrument department, where about 70 skilled hands are employed in the manufacture of electrical apparatus, such as astatic galvanometers, condensers, resistance coils, and other appliances used in electrical testing. Here were also seen the various instruments used for communicating through aerial and submarine telegraph lines, for instance the mirror instrument, the Morse, the single and double needle, sounders, &c. Besides these, there were shown the various instruments employed on railway lines for the safe conduct of the traffic, and notably amongst these Preece's block instrument and Walker's train describer. A considerable number of telephones and other instruments are also turned out.

The visitors then inspected the India-rubber department, where they were first shown the gum in its crude state as it arrives from Brazil, Guayaquil, Ecuador, Central America, East and West Coast of Africa, Madagascar, and the East Indies. There is so much foreign matter, such large pieces of clay, stones, iron, wood, &c., found in the majority of gums that it is necessary to cut the lumps open by manual labour. When this matter is picked out, the India-rubber is placed in tanks of boiling water to soften it, and is then passed through a series of washing machines, which besides washing thoroughly amalgamates it. After this process the gum is taken to a heated room, called the stove, where it remains for some time, and becomes perfectly dried. From this room it is taken as required for manufacture.

The next process is the mixing, and on account of the numerous varieties of gum, probably 20 in number, and differing materially from one another, the mixtures with sulphur and various pigments have to be very carefully considered, both with regard to the particular variety of the gum and the purpose to which the material is to be applied. In mixing, the principal additions to pure rubber are bi-sulphide of antimony, litharge, oxide of iron, French chalk, lamp-black, besides other pigments, and in all cases a certain percentage of sulphur is used, as this is the chief agent in the process known as vulcanising or curing.

The classes of manufacture can be generalised under two heads, one, the production by dry mixing of materials destined to produce what is known as solid goods such as railway buffers, valves, &c., and the other, the mixing of rubber in solution with the various pigments for the production of "spread" goods such as waterpoof coats and sheets. The dry mixing is effected by working the rubber between heated rollers and adding the pigments as required. This mixture is then placed in the heating machine preparatory to being run through the calender rollers to produce a sheet of the thickness required for the special object in view. This sheet is taken to the cutting shop where it is cut out in the shape desired. The material is then cured or vulcanised, depending on the purpose to which it is to be put, either by being placed in a mould and cured under hydraulic pressure, or imbedded in French chalk and submitted to high temperature in an oven, or rolled on a cylinder and boiled under pressure, or dipped in a boiling sulphur bath. The curing of rubber consists in submitting it to a heat of from 260° to 290° Fahr. in the presence of a certain proportion of sulphur.

In this shop was seen the manufacture of valves, railway buffers, washers, rubber rings, mats, wheel tyres, tennis balls, ink erasers, bottle stoppers, &c. Some idea of the extent of this shop may be gathered from the fact that there are eight engines constantly at work, the largest of which is of 500 horse-power.

The spreading shops, where the rubber in a state of solution is laid on cloth or other material for the purpose of waterproofing, were next visited. Twenty-four spreading machines were at work, and their ordinary production is over 10,000 yards per week, but their working capacity is far in excess of these figures. It was explained that to ensure perfect waterproofing the best classes of material are passed through the machines as often as ten times. The visitors were then taken to the waterproof tailoring department, where some 200 hands are employed. The vulcanising of this class of goods, called the semi-cure, was not visited on account of the offensive smell from the curing agents, bisulphide of carbon and chloride of sulphur.

The hose or pipe-making and the belting or driving band shops were then inspected. On account of the special work each of these shops is about 180 feet long, and about 40 feet broad. They are fitted with long curing ovens, in which the hose or piping is vulcanised in lengths of about 80 feet. The belts or driving bands when made are taken to the presses for curing.

The large chemical laboratory presented considerable attractions, but the time being short the visitors were hurried to the ebonite shop, where the manufacture of an infinite variety of ebonite articles was witnessed. It is here that large pumps and piping in ebonite for the Rio Tinto and other copper works, and for manufacturers of acid are made, ebonite being the only material successfully employed in works of these kinds. It was explained that ebonite or vulcanite is (without entering into much detail) ordinary rubber with an increased proportion of sulphur and a longer exposure to a high temperature; this change of treatment altering completely the nature of the material, which loses its elasticity, and can be worked in almost the same manner as wood or iron. The visit here terminated, and the guests were conveyed to London by a special train.

Before leaving we were informed that at the company's works at Persan-Beaumont, France, very much the same manufactures are carried on, but naturally on a smaller scale, only 300 people being employed there, whereas at Silvertown there are about 2,000 work people. From the position of these works very little submarine work has been done, but a great deal of work of various kinds has been there executed for the French Government. We understand that a con-

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siderable quantity of belting of a metre wide was made there as a special order for the Panama Canal Company, these being the only works in France which could execute the order.

Among the visitors to the works we noticed the following gentlemen :—

Chief Justice Dobson, Tasmania; Captain Da Silva, Portuguese Navy; Baron de Costa Ricci; Hon. W. Wilson, Victoria; Dr. Julius Von Haast, C.M.G., New Zealand; Capt. Roche, Gambia; Major-General Sir Peter Lumsden, G.C.B.; Hon. C. Oinmet, Quebec; Capt. Fitzgerald, R.N.; General Sir E. Selby Smyth, K.C.M.G.; Lieut.-General Sir Harry Lumsden, K.C.S.I., C.B.; Sir Samuel Davenport, South Australia; Capt. Verney, R.N., M.P.; Count Thadée d'Oksza; Major-General Sir Wm. Crossman, R.E., K.C.M.G., M.P.; Sir Juland Danvers; Capt. J. E. Hunter, R.N.; Sir Fredk. Goldsmid, K.C.S.I.,; Mr. Graves; Mr. Henry Ford; Sir Henry Mance, C.I.E.; Mr. Baughan, C.B.; Mr. W. H. Preece, F.R.S.; Mr. W. H. Winter; Capt. Hixson, R.N.; Mr. Sivewright, C.M.G.; Hon. Mr. Ross, Canada; Mr. Owen Lewis, Chairman of the Spanish National Telegraph Company; Mr. John Miles, Director of the West African Telegraph Company, and Mr. Thomas Fuller, Managing Director of the African Direct Telegraph Company. The directors of the Silvertown Company who received the guests were Mr. Silver, the Chairman of the Company, Messrs. Bannatyne, Scott, R. Henderson and M. Gray.

A NEW PRIMARY BATTERY.

A DECIDED new departure from the well-worn groove in which experimenters on primary batteries have hitherto worked is a novelty which is deserving of more than a passing notice. The new battery, which is the invention of Mr. Upward, the head electrician to the Woodhouse and Rawson Electric Manufacturing Company, occupies an intermediate position between the gas battery of Grove and the ordinary primary element. To a certain extent the idea is not new, as anyone who has read through the pages of the *Electrician*, an electrical journal which had a brief existence of about two years, a quarter of a century ago, will remember that many attempts were then made to construct batteries on somewhat the same lines as those followed by Mr. Upward, but apparently without any success. The energetic action of chlorine in a gas battery was pointed out by Grove, and it seems probable that this fact has been a suggestion to the inventor of the new battery. Briefly speaking, the construction of the latter is as follows :—The elements are the ordinary carbon and zinc, or carbon and iron, and the battery is maintained in active condition by the passage of chlorine gas through the cells. Each cell consists of an outer and inner vessel; the outer one, which is of glazed earthenware, is provided with air-tight inlet and outlet pipes, while the inner vessel is an ordinary porous pot. Between these two vessels the carbon plates are placed, and tightly packed in with crushed carbon, cement is then used to seal the top of this outer chamber. In working the battery the most ordinary commercial zinc cast into blocks, and without any amalgamation, is placed in the inner cell, which is then filled up with plain water. Chlorine gas, which may be obtained from common chloride of lime, is then admitted to the outer or sealed chamber, and circulates from cell to cell through the whole system. The pressure inside the cells being less than atmospheric pressure, there can be no leaking of the gas.

In order to supply the cells with a constant flow of chlorine, a simple gas holder, working on the displacement principle, is used, chlorine being two-and-a-half times the weight of air. This gas holder, which has no moving parts or valves of any kind whatever, is capable of holding sufficient to work the battery without interruption, even although the gas may be generated at intervals.

Owing to the comparatively high resistance of the cells (about ·2 ohm) the battery is not used direct for electric lighting purposes, but is connected to a secondary battery or accumulator, so as to enable it to be worked at its highest efficiency, automatically charging the cells night and day without stopping.

The advantages which are claimed are :—1. No emptying and filling the cells with acids or chemical solutions of any kind whatever is required, plain water only being added occasionally.

2. The plates are never touched or moved in the battery from the time the zincs are put in till they are completely used, which, if required, need only be about once in six months of usual electric lighting work.

3. When the battery is at work the zincs are consumed perfectly evenly, down to a thin wafer, thus using the whole plate without waste. Since the action of the battery is purely electric, all the zincs will be consumed evenly with one another, and may all be renewed on the same day.

4. The carbon plates are once for all sealed into their places, and never removed.

5. The battery may stand idle for months, and the zincs will be absolutely untouched.

6. There is no creeping, and consequently the terminals are not liable to corrode or require cleaning or screwing up.

7. There is absolutely no polarisation whatever.

8. Local action is impossible, owing to the electrolytic action of the battery.

9. No washing of porous pots or other parts of the battery is required.

10. There is no smell, dirt, or obnoxious vapour.

11. The removal of the plates for amalgamation is not necessary, and the cheapest scrap cast zinc can be used.

12. The whole apparatus may be left standing for months without any depreciation, and will start instantly when desired.

13. One of the chief features of the battery is its permanent nature. All that is necessary is to make the gas, which by the special design of generator is rendered exceedingly simple, and does not occupy more time than trimming two or three oil lamps.

14. The light is available at any hour of the day or night, and is absolutely constant and steady.

15. Light can be turned on and off as required without altering the amount of light given off by the remaining lamps.

16. The high E.M.F. (2·1 volts) is that due to the direct action of chlorine on zinc, and is not obtained by the use of a depolariser as in other high E.M.F. batteries.

The general construction of the battery (of which we shall have more to say) is most substantial and satisfactory, and we consider that the invention is a very close approach to the theoretical perfection as regards economy which it is possible to obtain from a primary battery in which zinc is used as the positive element.

Finding Buried Miners.—In its Paris letter, *Science* for May 7th, mentions a very ingenious and valuable device by which some workmen buried in a mine near Périgueux, in the south of France, were sought. After these workmen had been buried by an avalanche of rocks and earth, MM. Siemens and Langlois, the engineer and photographer, finding that all attempts to communicate with them proved ineffectual, had a hole bored down directly into the cave, large enough to admit of passing provisions and tools, and they sent down into the hole an electric lamp strong enough to illuminate the whole cave, and after that a photographic apparatus. The plate, after some time of exposure in the cave, came up so perfectly impressed that it revealed the exact state of things. True, the scene was ghastly indeed, and dead bodies only were pictured by it, but the experiment proved that this plan may hereafter be resorted to with success in mine accidents.

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BLEACHING BY ELECTRICITY.

IN the field of electro-chemistry one of the most interesting and ingenious operations of a practical character is that invented and brought to a stage of commercial success by M. Hermite, in which the process of bleaching is carried out by electrolysis, and to which reference was made in the REVIEW of February 5th last. The method was exhibited and explained at the Antwerp Exhibition, and since then has been in practical operation on a business scale at Lille. M. Hermite is now in London, and Messrs. Paterson and Cooper having been appointed his sole licensees are commencing the manufacture of the requisite plant on a scale commensurate with the expected demand from the bleaching works of the United Kingdom. One great advantage claimed for the electric process is that a saving in cost is effected of about 50 per cent. as compared with the use of bleaching powder; and another is, that it does not involve that danger to the tissues operated upon, which exists in the present process, owing to the presence of lime in the bleaching solution. Under the present system textile materials are not bleached perfectly white, but at a certain stage of the chemical process have to be withdrawn from its influence and perfected by the tedious operation of bleaching on grass. This is rendered unnecessary by M. Hermite's mode of working, the bleaching being completed with the one operation, thus effecting an economy of both time and money. The working of the apparatus is very simple, and by means of an ammeter and voltmeter it can be regulated and controlled at any distance from the bleaching tanks. A solution of chloride of magnesium is submitted to the action of an electric current with an electromotive force of 4 volts through platinum electrodes, causing chlorine to be liberated, and at the same time oxygen from the water; a cycle of changes taking place which result ultimately in the regeneration of the chloride of magnesium. There is, therefore, no practical loss in the chloride of magnesium, and it is due to this fact, together with its low price (£2 per ton as compared with £6 10s. for bleaching powder) that the plan shows such a saving of cost as compared with that generally adopted hitherto.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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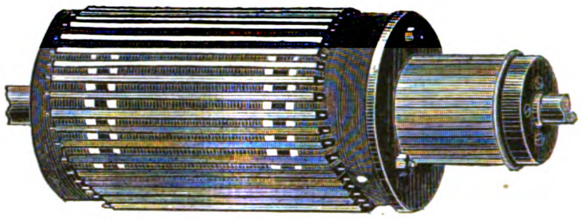
(*Continued from page* 551.)

THE name of Edison has held a strange sway over the masses for several years past, and has been most successfully employed by unscrupulous speculators as a means with which to conjure. When it was announced that the "Wizard of Menlo Park" had succeeded in subdividing the electric incandescent light, down went the gas shares to panic prices.

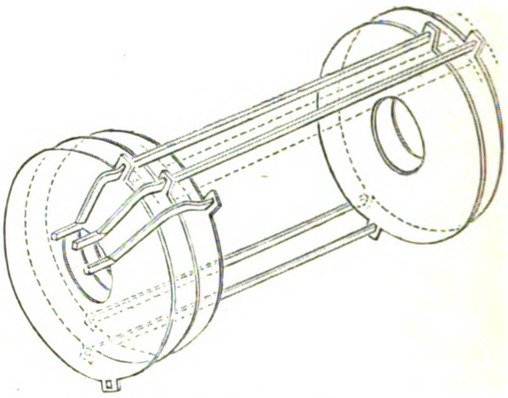
It is not only amongst the ordinary public, however, that Edison exercises such a peculiar fascination; even the greatest of your legal luminaries cannot free themselves from his mysterious influence. He has been held to be the inventor, without a shadow of reason, of every conceivable telephonic transmitter. He is credited with being legally entitled to claim a monopoly in incandescent electric lamps, although they had been employed in various forms years before his time, and no one, least of all your humble servant, would be surprised to find that if it were thought advisable to set him up as the inventor of myself and family, the prior discoveries of Varley, Wheatstone, Siemens, Gramme and others would be set at nought. Edison, the designer of the phonograph, or "talking machine," is, in the public mind, a great and original inventor. In reality he is an exceedingly clever adapter of and improver upon old and almost forgotten ideas which from want of means, or from other causes, had never been carried to finality, and had been laid aside *pro tem.*

To the man who has a liking for and a smattering of scientific knowledge, and who keeps himself *au courant* with the progress of invention by reading sensational, and almost invariably inaccurate newspaper paragraphs, Edison is a name to swear by to the utter exclusion of others before or since.



ARMATURE.

It must not be supposed, however, that I depreciate the constant and successful labours of this fortune-favoured American. By means of the money at his command, with which he has been lavishly endowed from the very commencement of his electrical career, and the co-operation of clever helpers in all the domains of his researches, he has been enabled to give the world the benefit of many important additions to its progress which might otherwise have still lain dormant. In science, as in everything else at the present day, there is a little too much of the hero worship of the successful man who turns the ideas which others have promulgated to business or commercial account, and too little heed is given to the patient and oftentimes nearly forgotten investigator whose earlier labours have been exhumed, "resurrected" and transfigured almost beyond recognition, except to the earnest student.



METHOD OF COILING ARMATURE.

But to our history. I have said that the Edison form of dynamo somewhat resembles that of Siemens, insomuch that the coiling of the armature is identical in principle. In practice, however, the methods adopted in the two cases are quite distinctive features. The Edison armature, as generally constructed, is not coiled with wire as we understand it, but with copper bars, and in this respect it much resembles the coiling of the old electro-plating Gramme machines, as well as those manufactured by Siemens for the same uses.

These bars, however, only cover the outer surface of the armature; and as it would have been an awkward matter, if not one of sheer impossibility, to bend these massive bars over the ends of the armature, as Siemens coils his wires, Mr. Edison adopted a very ingenious device for obviating this difficulty. The figure shows an Edison armature in its complete form, and it will be seen that the ends of the copper bars are connected across from one side to the other by discs or rings of copper threaded upon the axle and carefully insulated one from the other.

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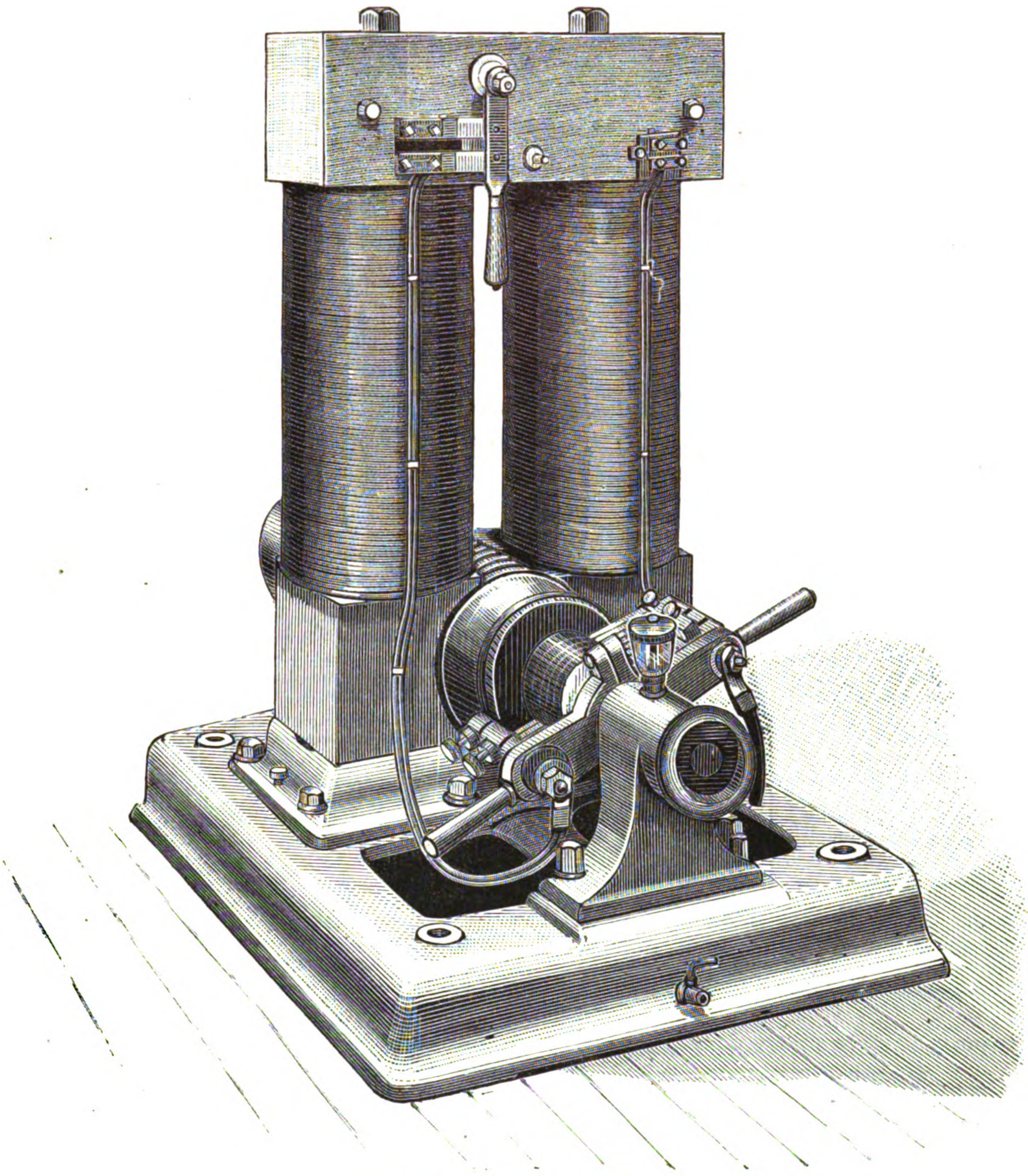
These discs are provided with projecting lugs to which the copper bars are attached. The method of connecting up may be made still more plain by means of a diagram, in which the alternate discs and bars are represented by dotted lines. The coils, each of which, you understand, consists of a copper bar on each side of the armature, are connected to a collector of the form I have previously described. The figure, as you can see for yourself, does not give an idea of the internal construction of the armature, nor indicate the means provided for the suppression of the Foucault or "eddy" currents, to whose deleterious influences I alluded when speaking of my Brush form. The core of the armature is, in fact, built up of a series of thin iron washers carefully insulated or separated from one another by mica or paper.

The field magnets designed by Edison for his armatures were not of a form such as one would expect from one of his knowledge and experience; they were, indeed, very defective, as we have since learnt.

Dr. Hopkinson, F.R.S., one of your leaders in science, has quite recently very materially improved my Edison form; some of these improvements being in the field magnets, rendering them much more effective, others having been introduced in the armature, still further eliminating the "eddy" currents, which circulated somewhat freely in the earlier forms. This machine, unlike the Brush, is chiefly used for producing the current for incandescent electric lighting, although it has been employed in a very limited capacity for arc lamps. This large illustration gives a capital idea of the Edison-Hopkinson form into which members of my family have been turned. They have met with considerable favour in this country, although naturally they are more generally sought after on the other side of the "herring pond." The principles which underlie the various fashions under which I have thus far presented my counterparts to you are common to all of us, and with the bare mention of a few of my brethren who are best known I think I must very shortly bring my history to a conclusion.

(*To be continued.*)



AN EDISON-HOPKINSON DYNAMO.

CONFERENCE ON SUBMARINE CABLE PROTECTION.

WE notice from the official report of this Conference, issued by the Ministry of Foreign Affairs, that all the clauses of the Convention of 1884 have been ratified with the exception of Articles 2 and 4, the text of which gave rise to considerable discussion These Articles are as follows:—

"Article 2.—The breaking of or injury to a submarine cable when effected voluntarily or through culpable neglect and which might result in the interrupting or impeding either wholly or in part of telegraphic communications, is punishable, in addition to the civil action for damages."

"This law does not apply to the cases of break or injury resulting from the legitimate endeavour to protect life or secure the safety of vessels, after all necessary precautions have been taken to avoid such break or injury."

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"Article 4.—The proprietor of a cable who by the laying or repair of this cable breaks or injures another cable must bear the cost of the repair which this break or injury may have rendered necessary, and shall be liable, if there are any reasons for it, to the application of Article 2 of the present Convention."

The Submarine Telegraph Act (Great Britain) of August 6th, 1885, says in Article 4:—

"Article four of the Schedule to this Act shall not apply to that part of a cable which is laid in a depth of water exceeding one hundred fathoms; but nothing in the Convention or this Act shall take away, prejudice, or affect any right or remedy to which by law any party is or may be entitled otherwise than under the provisions of the Convention or this Act."

Mr. Kennedy, on behalf of the British delegates, pointed out that as English companies owned the greater portion of submarine cables they were naturally anxious that their claims should be favourably considered. He stated that the depth of one hundred fathoms was fixed upon as the limit of responsibility since that depth was beyond the limits of anchorage, and practically the extreme limit at which cables ran a great risk of being injured. He, therefore, asked that Article 4 of the English Act should be substituted for Article 4 of the Convention.

The committee having presented its report, and the clauses referred to having been discussed, it was resolved to define the meaning of said clauses in the following terms:—

"Certain doubts having arisen as to the interpretation of the word 'voluntary' inserted in Article 2 of the Convention of the 14th March, 1884, it is understood that the application of penal responsibility mentioned in the said Article does not apply to cases of break or injury occurring accidentally or necessarily while repairing a cable if all precautions have been taken to avoid these breaks or injuries."

"It is also understood that article 4 of the Convention has no other object and should have no other effect than to entail upon the proper tribunals of each country according to their laws and with regard to the circumstances of the case, the duty of deciding the question of the civil responsibility of the proprietors of a cable who through the laying or repairing of this cable should cause a break or injury to another cable, and to decide upon the consequences of this responsibility should it be proved that such exists."

We understand that the following cable companies were permitted to give evidence before the committee appointed by the Conference, but they were not allowed to take any part in the discussion, or to vote.

	Capital.	Cable owned
		N. M.
Anglo-American Telegraph Company ...	£7,000,000	10,437
Black Sea Telegraph Company	130,000	351
Brazilian Submarine Telegraph Co. ...	1,450,000	7,496
Cuba Submarine Telegraph Company..	220,000	940
Direct Spanish Telegraph Company ...	235,379	1,175
Direct United States Cable Company ...	1,214,200	2,983
Eastern Telegraph Company	5,643,995	19,121
Eastern & South African Telegraph Co.	950,000	3,864
Eastern Extension Telegraph Company	3,560,000	12,612
Platino-Brazilian Telegraph Company...	483,480	1,058
West India and Panama Telegraph Co.	1,325,530	4,119
Western and Brazilian Telegraph Co....	1,498,650	2,543
West Coast of America Telegraph Co....	450,000	1,699
Totals	£24,161,234	68,398

THE ELECTRIC LIGHTING ACT AMENDMENT BILL.

THE Select Committee of the House of Lords having completed their enquiry into the question of amending the Electric Lighting Act of 1882, and the House of Lords having adopted the Bill which the Select Committee approved of, we are now in a position to explain the proceedings of the Committee, and to describe the result they have arrived at. Had not the enquiry been conducted with a degree of privacy unusual even in the Upper House of Parliament, we should have been able to record the labours of the Committee as they proceeded, as we did in 1882, and on other like occasions. In this instance, however, not only were the Press and the public excluded, but the witnesses were sternly enjoined to preserve their own counsel, and agents and other semi-official persons deeply concerned in the matter were only admitted upon special points and under the most rigid conditions. Even now the evidence is not published, but we have before us, at all events, a general view of the procedure adopted, and the Bill finally accepted and sent up to the House by the Committee. It will be remembered that with a view to remedying certain defects in the Act of 1882—especially the provision relating to the compulsory purchase of an installation at the end of 21 years, without compensation or allowance for profit, goodwill, or anything else—three Bills were introduced in the House of Lords this Session, viz.: by Lord Rayleigh (on behalf of the Electric Lighting Act Committee of 1884), Viscount Bury, and Lord Houghton (virtually representing the Government). After some debate these three Bills, differing somewhat broadly on material points, were referred to a Select Committee, consisting of the Earl of Camperdown, who became chairman, Earl Cowper, Lord Ashford (Viscount Bury), Lord Balfour of Burleigh, Lord Rayleigh, Lord Wigan (Earl of Crawford and Balcarres), Lord Methuen, Lord Houghton, Lord Wolverton, Lord Bramwell, and Lord Lingen.

This Committee met for the first time for actual business on May 10th, and in the meantime a large number of petitions for or against the respective Bills were presented to the House and referred to the Committee. Against No. 1 Bill (Lord Rayleigh's) petitions were presented from the Corporations of Birmingham, Newcastle, Liverpool, Blackburn, Bolton, Burnley, Glasgow, Manchester, Nottingham, Paisley, and Hanley, the Dundee Gas Commissioners, the Mile End Vestry, the City of London Commissioners of Sewers, and the Metropolitan Board of Works; while there petitioned in favour of the Bill, the Society of Arts, the Institution of Civil Engineers, and Lord Thurlow's Electric Lighting Act Committee; and for the amendment of the Bill, the Poplar Board of Works, the Gateshead Corporation, and the Strand Board of Works lodged petitions. No petitions appear to have been presented in support of No. 2 Bill (Lord Ashford's), but the Metropolitan Board of Works, the Dundee Gas Commissioners, the Commissioners of Sewers, and the Corporations of Birmingham, Newcastle, Liverpool, Blackburn, Bolton, Burnley, Manchester, Nottingham, Glasgow, Paisley, and Hanley, petitioned against it—the Strand Board of Works alone petitioning for the amendment of the Bill. In like manner all the last-named bodies (except the Newcastle Corporation and the Strand Board of Works) petitioned against No. 3 Bill (Lord Houghton's), and likewise the Electric Lighting Act Committee, the Dynamicable Society the Society of Arts, the Society of Telegraph Engineers and Electricians, the Institute of Civil Engineers, and Messrs. R. E. Crompton and Company. The Corporation of Leeds alone presented a petition in favour of the Bill, while the Newcastle Corporation and the Strand Board petitioned for amendments. The Corporation of Edinburgh petitioned that none of the Bills should be allowed to pass into law until the Municipal Corporations had been heard upon them. From these facts it would seem that none of the Bills was really desired, while all three were strongly objected to; but this view is misleading until it is remembered that in most cases the petitioners prayed "to be heard by counsel" against the Bills, the object being to obtain a *locus* before the Committee, and then to alter the Bills as might be desirable and possible.

Meeting on the 10th of May for evidence, the Committee held six subsequent sittings for the same purpose, during which they examined in all twenty-one witnesses (apart from occasionally consulting certain agents and others interested), viz.: Mr. Lionel Cohen, M.P., Mr. H. H. Gibbs, Professor G. Forbes, Mr. Rookes E. Crompton, Sir Frederick Bramwell, Mr. J. S. Forbes, Sir John Lubbock, Mr. John Matheson Macdonald, Mr. E. Oxford-Smith, Mr. Clement Dunscombe, Mr. G. Whiteley, Mr. Samuel G. Johnson, Mr. Hill Motum, Sir George Morrison, Mr. Preece, Mr. Robert Hunter, Major Armstong, R.E., Mr. Henry G. Calcraft, Mr. Albert C. Meysey-Thompson, the Honourable Reginald Brougham, and Mr. J. N. Shoolbred. The evidence being concluded the Committee seemed to have decided by general informal consent, to take up only No. 3 (Lord Houghton's) Bill, although it was not until the close of their proceedings that they resolved in set terms to report to the House that it was not expedient to proceed further with the other two Bills.

The leading object of these Bills was to amend Clause 27 of the Act of 1882, which enacts that where any electric lighting undertaking existed under a Provisional Order or a special Act, the local authority may "within six months after the expiration of a period of twenty-one years, or such shorter period as is specified in that behalf in the application for the Provisional Order or in the special Act, from the date of the passing of the Act confirming such Provisional Order or of such special Act, and within six months after the expiration of every subsequent period of seven years, or such shorter period as is specified in that behalf in the application for the Provisional Order or in the special Act," require the undertakers to sell to them their undertaking upon payment of the then value of the lands, works, plant, &c., without any addition in respect of compulsory purchase, or of goodwill, or of any profits which may or might have been, or be made from the undertaking, or of any similar conditions, the Board of Trade being left to determine any other questions arising out of the acquisition. In his original Bill Lord Houghton simply proposed to amend the Act first by substituting for the passage we have quoted above, the new, short proviso, after "may": "Within six months after the expiration of the prescribed period, and within six months after the expiration of every subsequent period of ten years, or such shorter period as is specified in that behalf in the Provisional Order or special Act;" and then adding at the end of the 27th section, thus modified, the clause: "In this section the expression 'prescribed period,' used in relation to the purchase of any undertaking, or part thereof, shall mean such period, not exceeding forty-two years from the date of the passing of the Act confirming the Provisional Order, or of the special Act authorising such undertaking, as may be specified in that behalf in such Provisional Order or special Act; provided that where no period is so specified the prescribed period shall be deemed to be a period of thirty years, and that no period exceeding thirty years shall be so specified in relation to the purchase of any undertaking or part thereof, except with the consent of the local authority within whose jurisdiction such undertaking, or part thereof, will be."

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This was the whole of the noble lord's Bill, but in committee it was not only considerably altered, but enlarged, and practically made a new Bill, as will be seen below. The period in the existing Act of 21 years (with successive 7 year periods), has been altered to 42 years (with succeeding 10 year periods); the difficulty respecting the question of compensation or other allowance, has been dealt with by empowering the Board of Trade to vary the terms of purchase prescribed in the Act of 1882; and elaborate provisions have been introduced with regard to the laying down of electric wires, in the interest of the Postmaster-General and the public at large. The Bill so amended was reported to the House of Lords, and in that form it was passed through Committee of the House, at the last sitting before the recess.

Appended is the full text of the Bill:

A BILL [AS AMENDED BY THE SELECT COMMITTEE] INTITULED AN ACT TO AMEND THE ELECTRIC LIGHTING ACT, 1882.

Be it enacted by the Queen's most excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :—

1. Section 27 of the Electric Lighting Act, 1882, shall be read and construed as if the words—" within six months after the expiration of a period of 21 years, or such shorter period as is specified in that behalf in the application for the Provisional Order or in the special Act, from the date of the passing of the Act confirming such Provisional Order or of such special Act, and within six months after the expiration of every subsequent period of seven years, or such shorter period as is specified in that behalf, in the application for the Provisional Order, or in the special Act," had been originally omitted from the sixth and following lines thereof and in lieu thereof the following words had been therein inserted: " within six months after the expiration of a period of 42 years, or such shorter period as is specified in that behalf in such Provisional Order or special Act from the date of the commencement of the Act confirming such Provisional Order or of such special Act, and within six months after the expiration of every subsequent period of ten years, or such shorter period as is specified in that behalf in such Provisional Order or special Act."

2. Notwithstanding anything in section 27 of the Electric Lighting Act, 1882, the Board of Trade may by any Provisional Order to be made by them under that Act, if they think fit, vary the terms upon which any local authority may require the Undertakers to sell, and upon which the Undertakers shall be required to sell to such local authority their undertaking or so much of the same as is within the jurisdiction of such local authority under the said section, in such manner as may have been agreed upon between such local authority and the Undertakers.

3. (1.) Where in any case any electric line or other work may have been laid down or erected in, over, along, across, or under any street, for the purpose of suppyling electricity, or may have been laid down or erected in any other position for such purpose in such a manner as not to be entirely enclosed within any building or buildings, or where any electric line or work so laid down or erected may be used for such purpose otherwise than under and subject to the provisions of a license, order, or special Act, the Board of Trade, if they think fit, may, by notice in writing under the hand of one of the secretaries or assistant secretaries of the Board of Trade, to be served upon the body or person owning or using or entitled to use such electric line or work, require that such electric line or work shall be continued and used only in accordance with such conditions and subject to such regulations for the protection of the public safety and of the electric lines and works of the Postmaster-General as the Board of Trade may by or in pursuance of such notice prescribe, and in case of non-compliance with the said regulations, then the Board of Trade may require such body or person to remove such electric line or work: Provided that nothing in this sub-section shall apply to any electric line or work laid down or erected by any body or person for the supply of electricity generated upon any premises occupied by such body or person to any other part of such premises.

(2.) Where in any case any electric line or work is used for the supply of electricity in such a manner as to injuriously affect any telegraphic line of the Postmaster-General, or to affect the telegraphic communication through any such line, the Postmaster-General may, by notice to be served upon the body or person owning or using or entitled to use such electric line or work, require that such supply be continued only in accordance with such conditions and regulations for the protection of the telegraphic lines of the Postmaster-General and the telegraphic communication through the same as he may by or in pursuance of such notice prescribe, and in default of compliance with such conditions and regulations the Postmaster-General may require that the supply of electricity through such electric line or work shall be forthwith discontinued: Provided that nothing in this sub-section shall apply to the supply of electricity through any electric line or work laid down or erected under and subject to the provisions of any license, order, or special Act, or which may be used in accordance with any conditions or regulations prescribed by the Board of Trade by or in pursuance of any notice given by them under this section.

(3.) If any body or person fails to comply with the requirements of any notice which may be served upon them or him under this section, such body or person shall be liable to a penalty not exceeding twenty pounds for every such offence, to be recovered summarily, and any court of summary jurisdiction, on complaint made, may make an order directing and authorising the removal of any electric line or work specified in such notice by such person and upon such terms as they may think fit.

(4.) Any notice authorised to be served under this section upon any body or person may be served by the same being addressed to such body or person, and being left at or transmitted through the post to any office of such body or the usual or last known place of abode of such person, and any notice so served by post shall be deemed to have been served at the time when the letter containing the notice would be delivered in the usual course of post, and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed and put into the post.

(5.) In this section terms and expressions to which by the Electric Lighting Act, 1882, meanings are assigned shall have the same respective meanings, provided that the term "street" shall include any square, court, or alley, highway, lane, road, thoroughfare, or public passage or place whatever, and the expression "telegraphic line" shall have the meaning assigned to it by the Telegraph Act, 1878.

(6.) Nothing in this section shall apply to any electric line or work of the Postmaster-General, or to any other electric line or work used or to be used solely for telegraphic or telephonic purposes.

4. This Act may be cited as the Electric Lighting Act, 1886; and the Electric Lighting Act, 1882, and this Act shall be read and construed together as one Act, and may be cited together for all purposes as the Electric Lighting Acts, 1882 and 1886.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 550.)

Thursday, May 13th, 1886—(*continued*).

PROF. DEWAR, re-examined by Mr. Aston: Calling your attention to the paragraph which occurs on the second sheet of M. Sidot's papers, in these words: "*J'ai obtenu des resultats analogues avec le lin, le chanvre, le coton, le papier, la soie*"—calling your attention to that statement, and assuming that you were operating upon a thread, and that you begun with the thread in the first instance before carbonising it, put it into your vessel, and then heated it gradually in the presence of the hydro-carbon vapour, should you then have obtained a filament like Edison's? —No.

Should you have obtained a filament which in your opinion could be usefully employed for Edison's incandescent lamps? —No.

What would have been the character of the material that you would have obtained from your thread, assuming that you had begun with the raw thread instead of beginning with the carbonised thread?—The results would be practically identical.

Can you give any reasons as a chemist for your statement that the results would be practically identical?—The deposit of carbon by the Sidot process could only take place after the carbonisation of the filament, and consequently it comes to the same thing in the end whether you insert the filament after carbonising it or before. It is a mere convenience of time.

The two stages of the process, then, will be, when you begin with the uncarbonised filament, first to effect carbonisation?—That would naturally result, in any case.

And, therefore, in your experiment yesterday, did you do anything more than carry into practical operation the second stage of the Sidot process, assuming that he begins with the raw thread?—Nothing more.

Now, I understand you to say that for the purpose of applying what my friend compendiously calls the flashing process, it would be unwise to begin with an irregular thread such as Sidot produces? It would be better to begin with the ordinary carbonised thread, would it not?—It would.

In your opinion, would the ordinary carbonised thread, as regards regularity, be more suitable for carrying on the flashing process with efficiency than the irregular Sidot thread?—Yes.

What kind of electric light, in your opinion, having regard to the year 1870 and the use of the pencils, was Sidot referring to?—The arc light.

Have you any doubt about it?—Not the least.

MR. JUSTICE BUTT: I want to ask one question, just to make it clear. Taking a filament, if filament is the proper word, produced from any of the materials spoken of by M. Sidot, could you get a regular filament or an irregular one, no matter whether you took the linen or silk or a piece of wood?—Do you mean just immediately after carbonisation?

No, after treating it by his process?—I say, irregular in all cases.

No matter whether it was a thread of linen, or silk, or a piece of wood, or whatever he uses?—It would make no difference.

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Charles Henry Gimingham, examined by Sir Richard Webster, stated that he had for five years been employed by the Swan and Edison United Companies, and was now manager of their factory at Ponder's End. He was the inventor of a form of connection between the platinum and the carbon in an electric lamp. He had never seen any mode of connecting two substances such as carbon and platinum in the way described in his specification before the date of his invention, and he still believed it was quite new. He dispensed with all boxwood or other material between the platinum and the carbon, and put the carbon straight into the platinum. In his opinion, a lamp made in accordance with his specification would burn perfectly well.

Mr. Justice Butt: Have you used lamps so made for a long time?—Not for any considerable length of time.

Examination continued: The connections were now frequently coated over with something. The lamp produced was made in accordance with his specification, and the connections had not been squeezed as suggested by the Solicitor-General; the socket had simply been formed and the carbon filament inserted.

Sir Richard Webster: I offer that lamp to my friends to be lit as long as ever they like.

Mr. Charles: It is very little use lighting it for five minutes.

Sir Richard Webster (To witness): How long have you had a lamp made in that way kept lighted?—Say 40 or 50 hours.

Mr. Justice Butt: Without deterioration?—Without apparent deterioration.

Sir Richard Webster: We do not suggest at all that it is not better as a commercial lamp to put something on the top.

Cross-examined by Mr. Charles: The mode of attaching the wire to the filament, as described in his specification, was not the one actually in use for incandescent lamps. A cement was now used. He was not aware at the time of filing his specification of the platinum sockets described by Mr. Swan, nor had he examined Mr. Swan's lamp containing those sockets. It had been explained, however, that the platinum sockets in Swan's lamp were not like his, inasmuch as they did belong to the platinum wire all in one.

Mr. Aston intimated that this was the plaintiff's case. With regard to the infringement, the manufacture and sale of the lamp complained of was admitted.

Mr. Justice Butt: Infringement admitted, if W and R is an infringement.

Mr. Macrory: We admit that we made W and R.

Sir Richard Webster: I do not propose to exercise the right which, I believe, prevails in this court of summing up the evidence. I think it is not desirable to do so in this case, because I have nothing to add to the opening, however imperfect it may have been, which I presented to your lordship, as to the existing prior state of knowledge. I say that all this mass of information, some misleading and some of value, amounts to nothing more than I opened to your lordship as to the four leading points. I have only one word to say with regard to the Solicitor-General's suggestion that I have in my opening invented or suggested the theory that Mr. Edison carbonised after his filament or conductor was formed. I only ask your lordship to remember that I read the actual passages in his specification, and I am prepared at any time to refer to them again. The Solicitor-General said that there was not one word in Mr. Edison's specification that supported that view. I am prepared, if necessary, at any time to call attention, not only to one, but to four or five passages in Mr. Edison's specification, in every one of which he refers to carbonisation after the filament or thread is formed, and there is no single passage to the contrary. Therefore, I only want to point out before the learned Solicitor-General or Mr. Charles addresses your lordship that it is not my suggestion, but that it is Mr. Edison's description of his own invention, and it was spoken to most pointedly by Sir Frederick Bramwell and by Dr. Hopinkinson, and I think by the others too, and they were not cross-examined upon that particular point. At line 44, page 23 of the specification, Edison says: "I have discovered that even a cotton thread properly carbonised and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from one hundred to five hundred ohms resistance." There the thread is spoken of as being a thread before carbonisation.

Mr. Justice Butt: I do not quite follow you on the point that the conductor was to be coiled and shaped afterwards. I do not see that the words carry that.

Sir Richard Webster: I am quite satisfied to submit it to your lordship's judgment. Your lordship will see what I mean here. I am pointing out that he says "I take a thread properly carbonised." I say that means a thread which is carbonised, and not a thread cut out of carbon. I submit that means carbonisation after it is made. That is the point I am upon.

Mr. Justice Butt: The Solicitor-General's point was that the carbonisation there is not after the further treatment.

Sir Richard Webster: No, my lord. Indeed it was not. The Solicitor-General's point was this, that there is nothing to show that he did carbonise before he made his thread. Now, at line 48: "If a thread be coiled as a spiral and carbonised." That is clearly carbonisation, not only after the thread is made, but after it is coiled. Now, returning to page 4, line 1: "Carbon filaments may be made by a combination of tar and lampblack." I agree for the moment it may look as though a carbon filament meant a filament of carbon. Your lordship will see it cannot be for this reason: "Carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material may be rolled out in the form of wire as small as seven one-thousandths of an inch in diameter and over a foot in length, and the same may be coated with a non-conducting, non-carbonisable substance, and wound on a bobbin or spiral"—that is, one or more times—"and the tar carbonised in a close chamber by subjecting it to a high heat, the spiral after the carbonisation retaining its form." It is utterly impossible to suggest that that is not carbonisation.

Mr. Justice Butt: The Solicitor-General did not suggest that at all. That is not what we are dealing with here.

Sir Richard Webster: With great deference to your lordship, it is what we are dealing with here. The learned Solicitor-General said: There is no word in the specification to indicate that the carbonisation took place after the conductor was formed.

Mr. Justice Butt: Now, you are wrong there. He said except in the case of the tar compound.

Sir Richard Webster: I will not argue it further. I will accept your lordship's correction; but it makes no difference to my mind, because I am dealing with what is suggested now, in order to prevent the patent being valid, that he indicates somewhere carbonisation before his conductor is made. I have pointed out the very passages, and my point is that not only were those passages consistent, but that there is nothing to the contrary. Now, if your lordship will look at line 22. If platinum wires are used, and the plastic lampblack and tar material be moulded round it, in the act of carbonisation there is an intimate union by combination and by pressure between the carbon and platinum. I need not remind your lordship that the platinum wires are the actual conductors up to the lamp, and in this case the carbon conductor is not carbonised until it has been put on to the platinum leads. That, therefore, shows clearly that it is shaped or formed. I am only arguing that it is brought into the condition of thread or filament in every instance before it is carbonised.

Mr. Justice Butt: I understand the Solicitor-General's point to be in effect this: I admit that in the case of that compound it becomes a thick putty, and is then rolled into a thread that is carbonised afterwards, but I say there is nothing in the patent to show that the filament used in the actual lamp was so treated.

Sir Richard Webster: I am aware your lordship has got it in your mind that it was, and I felt that if your lordship for the moment adopted the Solicitor-General's argument I ought to point that out.

Mr. Justice Butt: I have not adopted it. I do not know how the thing stands. I have not read it carefully enough. But the suggestion is that there was a compound which he describes coming to the consistency of putty. That, says the Solicitor-General, I admit is carbonised after it assumes that shape, but I do not admit that there is anything in the specification to show that what you use in these lamps was carbonised after it assumed the shape.

Sir Richard Webster: It is because the learned Solicitor-General has said that, that I thought it my duty to point out to your lordship that there is no passage in the specification that supports the view. It is not a question of his admitting it. It is a question of my not being able to show to your lordship that every passage in the specification is only consistent with carbonisation after the shape was formed.

Mr. Justice Butt: As I understand it, it was this: Sir Frederick Bramwell and your other witnesses laid great stress on this, that a filament was carbonised after it was made and shaped. He says there is nothing on earth in your specification to tell the public that this particular filament was carbonised afterwards and not before.

Sir Richard Webster: Your lordship is only putting it to me. I do not know, perhaps, that I ought to have addressed your lordship on the point. I point out that the Solicitor-General, subject to what he may say afterwards, is entirely wrong. There is everything on earth, and not only is there everything on earth, but there is no passage which supports the view that you are to cut this filament out of carbon. I cannot put it more plainly than that, that you are to cut it or shape it out of a carbon.

Mr. Justice Butt: That is the distinction, no doubt, whether you make the filament of carbon, or whether you make the carbon afterwards.

Sir Richard Webster: I hope your lordship understands I am not referring to the particular shape in which the filament is made. Now, will your lordship kindly look at line 39: "I have carbonised and used cotton and linen thread, wood splints, paper coiled in various ways." I need scarcely point out to your lordship that those are rough descriptions of the class from which he has made his conductors. In every single case, the form of the minute section has been produced before carbonisation took place. Then line 42: "If the carbon thread is liable to be distorted during carbonisation it is to be coiled between the helix of copper wire, and the helix is so fine that it may be eaten away with acid afterwards. The ends of the carbon or filament are secured to the platina leading wires by a plastic carbonisable material, and the whole placed in the carbonising chamber." Now line 51: "With substances which are not greatly distorted in carbonising they may be coated with a non-conducting, non-carbonisable substance, which allows one coil or turn of the carbon to rest upon and be supported by the other." I think I may fairly say in this short specification I have made good my point, that there is not one passage consistent with the view that the thread or filament, or conductor, of small section is to be cut out of an already carbonised material.

Mr. Justice Butt: You do not seem to me to go quite to the Solicitor-General's point. He says, unless you say in your specification clearly that this filament, of which you make so much

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perhaps justly, is made of a material and carbonised afterwards——

Mr. CHARLES: Show us how to do it.

Mr. JUSTICE BUTT: And show us how to do it, then your patent does not prevail. Is it sufficient to say there is nothing consistent with that?

Sir RICHARD WEBSTER: I am not going to argue the matter now. Your lordship will understand me. I say, as your lordship has been good enough to put that point to me, assuming our evidence as it stands now is that a competent man can make this lamp, there is not a vestige of authority, and there are a number of cases which I can cite to your lordship, for saying that that kind of criticism would invalidate the patent. I say most distinctly that if a practical way of making the lamp has been shown, as it is sworn at present and not cross-examined to ——

Mr. JUSTICE BUTT: There is a case clearly, but one has to weigh the evidence.

Sir RICHARD WEBSTER: I was only dealing with the particular point which the Solicitor-General put, that in the specification there was nothing to indicate, except in the tar case, that carbonisation was to take place after the thread or filament had been formed. I am only submitting that to your lordship's judgment. I submit to your lordship's judgment that there is everything in the specification, and that to say that people may try to do it wrong, contrary to the statement in the specification, is not the construction which is ever allowed to be put upon the specification. That is the way in which the lamp would be made, and if my learned friends were going to raise this point they should have cross-examined to it. We may have to call witnesses if they attempt it now.

Mr. JUSTICE BUTT: The way in which I imagine it can be applied is this: A set of witnesses say, I have read this specification and I say that any ordinary competent workman in this line could make a lamp from that specification. That is very good evidence so far as it goes. Then witnesses are called on the other side who say, I do not think he could. Then if that is so, in order to arrive at the right conclusion as to the relative value of the evidence you must look at the thing itself to see.

Sir RICHARD WEBSTER: That is really not what I was combating. If I had thought that was in your lordship's mind I should not have had the impertinence. I was going to say a word upon it. The Solicitor-General said, this is the fallacy which Sir Richard Webster suggested; there is not a word in the patent about it. It was that your lordship might not think we aquiesced in that view.

Mr. JUSTICE BUTT: I did not think it for a moment. It was hotly contested the moment the Solicitor-General said it.

Sir RICHARD WEBSTER: I thought it might be said we had acquiesced in the view that the specification has only got this doubtful view upon it. The other matter which I have to say a word about is this: your lordship was kind enough to say that we might mention any matter that we thought of importance to your lordship, and I venture to think that it may be of importance now that I should indicate to your lordship and my friends what we say about these anticipations as a matter of law. There are 75 anticipations. I have already told your lordship we are not going to examine them in detail any more. They do not amount to anything more than the state of knowledge which I indicated to your lordship, but I must ask you to allow me to read to you what is the recognised law as to the extent of anticipation which is necessary to void a patent. It has been laid down in three leading cases, Betts *v.* Menzies, which is 10 House of Lords cases, pp. 152-4, and there are many other passages, but these are enough for my purpose; Hills *v.* Evans, in 31 Law Journal, Chancery, page 437; and Otto *v.* Linford, of which I am obliged to give your lordship the judgment. The case has frequently been cited, but unfortunately the judgment has not been reported. Betts *v.* Menzies was not new law; it was in 1857; Hills *v.* Evans was in 1861; Otto *v.* Linford was in 1882. This rule has been acted upon literally in hundreds of cases, and I am only submitting it that your lordship may have what we say is the authoritative statement as to what there must be before my learned friends can move a step to suggest anticipations. They must be able to show that a practical workman, without experiment, can produce the patented article.

Mr. JUSTICE BUTT: That the defendants, setting up the anticipations, must show that that could be done from the documents.

Sir RICHARD WEBSTER: From the document before the date of the patent, and I need not say that that has to be read with the knowledge that existed at the date of our patent and not with subsequent knowledge. No living being has ever suggested that anybody ever thought of taking Sidot's filaments and using them in an incandescent lamp of any kind, and your lordship has got to deal with the anticipations, as giving the public the information. I say there is no case in which, where a new commercial article has been produced, for the first time, it has been held that any description of the component parts of that article put together, was an anticipation of that invention. It was put by Mr. Justice Brett in those very terms.

Mr. JUSTICE BUTT: I do not follow you. That they may not take a dozen or fifty papers or lectures or specifications, and say, if we put this and that and the other together, then we produce the thing?

Sir RICHARD WEBSTER: That I say distinctly where the article is new. There have been produced two cases where patents have been held invalid, but that is where the people have produced forms of the things before, and the question was whether the patented form was anything more than a slight alteration or change from what had gone before. But at present it stands in this way, that beyond Mr. Swan's experimental lamp, which died stillborn in December, no commercial carbon incandescent lamp, no practical incandescent lamp, has ever been introduced at all; and Dr. Hopkinson's evidence is that from December, 1879, there is a complete discontinuity. Up to that time there had been nothing, and since that time there have been hundreds of thousands. Asking your lordship to understand that that is our view of the facts, I want to read Lord Westbury's statement of the law in Hills *v.* Evans, I should like to read from page 463 of the Law Journal reports. That passage was read to Lord Westbury in Betts *v.* Neilson by my learned friend Mr. Aston, and Lord Westbury then said: "By the words of the statute of James it is necessary for the validity of a patent that an invention should not have been known or used at the time. These words are held to mean not publicly known or publicly used. What amounts to public knowledge or public use is still to be ascertained. One means of imparting knowledge to the public is the publication of a book or the recording of the specification of a patent." That is what the anticipations are here, as your lordship knows. "If, therefore, in disproving that allegation which is involved in every patent that the invention was not previously known, appeal be made to an antecedently published book or specification, the question is what is the nature and extent of the information thus acquired which is necessary to disprove the novelty of the subsequent patent. There is not, I think, any other general answer that can be given to this question than this, that the information as to the alleged invention given by the prior publication must for the purpose of practical utility be equal to that given by the subsequent patent. The invention must be shown to have been before made known. Whatever, therefore, is essential to the invention must be read out of the prior publication. If specific details are necessary for the practical working and real utility of the alleged invention they must be found substantially in the prior publication. Apparent generality, or a proposition not true to its full extent, will not prejudice a subsequent statement which is limited, accurate, and gives a specific rule of practical application. The reason is manifest, because much further information, and therefore much further discovery, are required before the real truth can be extracted and embodied in a form to serve the uses of mankind. It is the difference between ore and the refined and pure metal which is extracted from it. Again, it is not, in my opinion, true in these cases to say that knowledge, and the means of obtaining knowledge, are the same. There is a great difference between them. To carry me to the place at which I wish to arrive is very different from merely putting me on the road that leads to it. There may be a latent truth in the words of a former writer, not known even to the writer himself, and it would be unreasonable to say that there is no merit in discovering and unfolding it to the world. Upon principle, therefore, I conclude that the prior knowledge of an invention to void a patent must be knowledge equal to that required to be given by a patent, namely, such knowledge as will enable the public to perceive the very discovery and to carry the invention into practical use, and this appears to be consistent with the decided cases." Then his lordship goes through them. I will not read more, but I think I, at any rate, have shown your lordship it is a clear decision in accurate general terms of what is necessary. Of course, at the end of this case, we shall contend that nothing of the kind, at present at any rate, has been shown here. Now, my lord, in the much debated gas engine case, which has since been before Mr. Justice Pearson and confirmed by a judgment of his, after the most thorough investigation, Lord Justice Brett and Lord Holker—and I may say that Lord Justice Brett paid a well-deserved tribute to the great knowledge Lord Holker had in these matters—treated the rule in a way I should like to put to your lordship, because it is 20 years after Hill v. Evans was decided. Lord Justice Brett says: "Then what is the rule when you rely only upon a description in writing as being an anticipation. It seems to me that it is not sufficient to say that if a machine were made by a person who had read that writing, something in that machine would, if it had been really a machine used, have been, by reason of that user, an anticipation of the plaintiff's patent. You must go further, and where you allege that an anticipation in writing, and in writing only, you must show that a person—I mean a person conversant with such matters—reading that writing would find in it a reasonably clear description of the plaintiff's invention in the writing alone. If it requires that a machine should be made in order that the anticipation may be seen the subsequent inventor is not obliged, when his attention is called to a mere writing, to make a machine from it in order to see what will be the effect of that machine. He has to find a description of his own invention on the face of that writing, construing that writing reasonably as an invention. Therefore, even if the defendants here could show that, with corrections suggested by Sir Frederick Bramwell, a machine were made according to Johnson's specification which would work, and if they showed that in that machine, or a part of it, the same effect as in the plantiff's machine would really and substantially take effect in their machine, yet they cannot succeed unless that working of the machine is described substantially in Johnson's specification and described so clearly that a person conversant with such things upon reading Johnson's specification carefully would say, that is a description of the plaintiff's invention."

Mr. JUSTICE BUTT: Johnson's specification was the anticipation there?

Sir RICHARD WEBSTER: Yes. "That seems to me to be the effect of the judgment in Hills *v.* Evans, and also if you apply

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what was said in Betts *v.* Neilson." Lord Justice Holker said this: "The anticipation which is relied upon consists of a specification filed by Johnson. Well, the question is, not whether those letters patent have been filed, not whether those letters patent show any invention. That is not the question, but whether it describes in an intelligible way the invention of the plaintiff's. I take it to be clear that unless the specification describes the invention of the plaintiff's there is no anticipation. It seems to me there is a great difference between a specification which is relied upon as an anticipation and a machine which is relied upon as an anticipation." That is what I had in my mind when I spoke of the difference between letter-press and a new commercial article which has never been produced. "If you were to produce a machine which was made for a particular purpose, and which would accomplish when used results which were not thought of when it was made, were not anticipated, possibly the machine itself without any user would be an anticipation. I should doubt that very much myself. I do not find any authority upon it one way or the other. But I think it is perfectly clear that the machine if used so that the public could ascertain what it would effect would be an anticipation, but that is quite a different thing from producing as an anticipation a specification, for you cannot at all expect from the language of the specification what results the contemplated machine may accomplish. We have it declared in Hills *v.* Evans; it is not necessary for me to read the passage, but it is stated there as the law, and it seems very sensible, that the specification which is relied upon as the anticipation of an invention must give you the same knowledge as the specification of the invention itself. That seems a very sensible and reasonable rule. Now what do you gather from this specification of Johnson's." Then he argues it on the details of the specification, and I need not refer to that. Of course I am not at all suggesting that you are not honestly to take, if necessary, two documents which are public knowledge and put them together if they indicate discussion or invention or discovery in the same line, but you are not to piece together parts which are now found to be useful, which were never intended to be put in combination before for the purpose of building up a combination which has never in fact even existed or been described prior to the time that the patentee had disclosed his invention. In Van Heyden *v.* Newstadt, Lord Justice James said: "No mosaic construction of prior documents can be used so as to set up an anticipation." I do not put it so epigrammatically as that in my observations. I am not going to transgress the rule I laid down for myself. Betts *v.* Neilson is in the Law Reports, 5, House of Lords, page 15. There your lordship will find Lord Westbury repeated and re-enunciated what he had said in Hills *v.* Evans. It will fall to my learned friend Mr. Aston, or to one of the counsel for the plaintiffs, to address your lordship at the conclusion of the defendants' evidence. I submit, at present, that I have sufficiently brought to your lordship's attention the propositions of law that are necessary in support of our view of the case.

(*To be continued.*)

THE INCANDESCENT LAMP PATENT CASE.

(*Continued from page* 540.)

SECOND ACTION.

WE have then examined the legal aspect of the first action. Difficult as it is to form an accurate opinion on it, the second action will be found, we think, more troublesome still. The action was brought to restrain the defendants from performing the operation known as "flashing"—that is, of heating the filament with the electric current while immersed in a hydro-carbon atmosphere.

The patent sued upon was Cheesbrough's, 4,847, 1878, being a communication from Sawyer and Man of America. When first taken out the patent was undoubtedly void, inasmuch as out of the 29 claims in it, 25 had been previously published in England, by the depositing in the Patent Office of a copy of an American patent for the same matter, and by the same persons. This defect was afterwards remedied by disclaimer. As amended, the patent commences by stating that its object is "the production of an improved electric lamp, and the production of a better carbon for the use of electric lamps." It then points out that imperfection in vacua had been up to that time the reason why no lamp had been practically operative. After describing a lamp (which, by the way, appears to be remarkably like one patented by Kosloff in 1875, and which consisted of an incandescent rod of carbon in a bell jar of nitrogen), he goes on to describe a method of making carbons for incandescent lighting. "It has been found," he says, "that a pencil of carbon immersed in a hydro-carbon gas or liquid, and heated to an extremely high temperature by the voltaic current, is not itself attacked but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright grey colour, upon the exterior surface. As the carbon increases, more current is required to maintain its temperature, and if the current is gradually increased in accordance with the demand for it, there is, appearingly, no limit to the increase in mass of the homogeneous exterior deposit. Carbon pencils may be cut from the deposit, or the original pencil with its coating may be used in the lamps.

"In this process it will be seen that the carbon is never in contact with the liquid in which it is immersed, but surrounded with a carbonic gas of very high temperature, beeswax, balsam, and most oils if pure operate satisfactorily, almost any hydro-carbon in fact will answer. . . . . The before-going is a descriptive method of charging a sealed globe with pure nitrogen gas, let it be supposed that the pencil of carbon held between two carbon pieces of greater mass than that of the pencil above described, is immersed in the hydro-carbon liquid and heated in the manner already described, being then cleansed in alcohol, the pencil and its holders without having been disturbed are placed in the globe in which they are to be hermetically sealed."

The inventor then says: "I do not claim the construction of the lamp hereinbefore described, but what I do claim is, *first*, the hereinbefore described method of preparing the illuminating part of an electric lamp, consisting of electrically heating the same while it is surrounded by a carbon gas or liquid.

"*Second*, a material for the manufacture of the illuminating conductors of electric lamps produced by electrically heating carbon in a carbon gas."

At the trial it was apparently admitted that the defendants flashed their filaments electrically in a hydro-carbon gas or liquid.

Now it will be noticed that there are several curious points about this patent. In the first place the inventor, after describing the use of a hydro-carbon, claims a "carbon" gas. But carbon gases, such as carbonic acid or carbonic oxide, will not do. So that to make his claim good we must probably read "carbon" gas as if it were "hydro-carbon gas"—a rather strained reading, for the only other way of supporting the patent would be to read it "any carbon gas that will do"—but such a reading as this could surely never be sustained. In the next place it is to be noticed that the first claim claims "The hereinbefore described method"—but on turning to the description we find that it specifically treats of a particular method of flashing, so as to cement the carbon pencil to its carbon holding-blocks—a method not used by any one now. The next claim is for the material as a material for the manufacture of incandescent lamps.

The chief defence raised at the trial was that the second claim was old. The instances alleged were, firstly, a discovery of the celebrated chemist Despretz. In his endeavour to melt carbon, the most refractory substance known, Despretz was led to heat it by a very powerful battery, placing it in a lamp with as good a vacuum as he could obtain, and also in various gases. Fearing still that the carbon, instead of melting, might be dissolved or dissipated through the action of the surrounding media or gases, he hit upon the idea of using as a surrounding medium a gas already rich in carbon, and which was hence not likely to desire any more. Here appeared the unexpected result that the carbon became gray, springy, and metallic, and had all the characteristics of Sawyer and Man's carbon.

Some years after this, M. Sidot proposed a new method of making carbon, by heating, by means of a fire, wood, threads, and such like vegetable matters, placed in a porcelain tube, and surrounded with

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vapour of disulphide of carbon (which is not a hydro-carbon), and he also mentioned various forms of hydro-carbon as suitable for this purpose. He, too, noticed the elastic, metallic character of the product, for he even made a sonorous bell out of such carbonised wood, and suggested it as a useful substance for the carbons of electric lamps.

On these facts it was argued that at least the *material* was old, and that therefore the second claim was bad.

In his judgment the judge dealt with the various points that had been raised in succession; he then went on to say that "in using the words hydro-carbon gas, the patentee clearly could not have meant what chemists understand by a hydro-carbon gas (*i.e.*, a gas consisting only of carbon and hydrogen); that is clearly not what he was referring to, ... but it is said 'well, but (if you do not read it as meaning hydro-carbon gas) you will be including some gases, as carbonic acid and carbonic oxide, which, if applied, would not produce the result at all.' . . . . . If the specification is really to be read as a direction to the public to use either one of those gases, then I shall agree that the process described is a futile one . . . . . I really do not think he meant that . . . . . he has used the expressions hydro-carbon gas, carbon gas and carbonic gas. From the evidence I say I do not think he meant exactly what he said in using any of these expressions;" and his lordship then went on to say that he had come to the conclusion that anyone would know that carbonic acid and carbonic oxide gases would not do. But here we have a right to demand "if the patentee meant none of these things and did not mean what he said, then what did he mean?" It is a new thing in patent law that we are to go behind what a man says, and confirm his patent to him for what he "meant," on the ground that he did not mean what he said; but it is newer still to do this when at the very same time you confess your inability to say what he did mean! If he meant hydro-carbons according to the usual acceptation of the word, then beeswax is not a hydro-carbon, nor is carbon disulphide—if he meant carbon or carbonic gases, then numbers of them will not do. This part of the case still seems to rest in the greatest confusion, and it is greatly to be hoped that on appeal the Court will really determine what the patentee did say and what he is to be taken to have said, so that the public may clearly know what the patent is really for.

As to Sidot's process, the judge decided that it would not produce a material similar to that of Cheesbrough's. In this he differed from some of the plaintiffs' witnesses, who admitted that it would. The reason he gives for his opinion is, that by Sidot's process you apply external or furnace heat, thus producing uniformity of heat, which in its turn produces "uniformity of deposition per unit of surface, and that is just what you do not want in your process for producing the carbon conductor described by Mr. Cheesbrough." As to the anticipation of Despretz his lordship says: "There is one most important object obtained by the process patented by Mr. Cheesbrough which I think the defendants have failed to show that Despretz's process would yield. The principal object of this patent is to ensure the filling up in the course of the treatment of the pores of the carbon, the porosity of ordinary carbon being a serious objection to its use in incandescent lighting. Now one part of the process described is the gradual increase of the electric current. This was certainly no part of Despretz's process; it is an important matter. All, or nearly all, the witnesses have referred to it as a matter of significance, and Prof. Dewar's evidence on this point is as follows:—'He' (that is, the patentee) 'also points out the advantage of a gradual increase in the intensity of the current. For Cheesbrough's purposes you must have an intense electric current increased from a less intense one.'" Now with every respect we are fairly entitled to ask the reader to look back at the words of the patent printed above and see where the necessity of such gradual increase is pointed out? What Cheesbrough says is, that "*If* the current is gradually increased there is apparently no limit to the increase of the homogeneous exterior deposit"—and that, not for the reason that any gradual increase of current is needed to form the substance, but simply (as Cheesbrough says, and every electrician knows) that "as the carbon increases more current is needed to maintain its temperature," and he then goes on to suggest the cutting of carbon pencils out of the deposit so formed.

This is the most difficult point to understand in the whole judgment, for here again Cheesbrough appears to have been made to invent something that he certainly does not appear to have discovered, nor in words to have pointed out.

His lordship further pointed out that even if he had not adopted this view, that then even if Despretz process had really anticipated Cheesbrough's material, it is very doubtful whether it would, unused as it was, have been really a true anticipation.

Here, then, we have the grounds upon which the decision proceeded, stated as fairly as the difficult and complicated nature of the case seems to allow. Should the patent be upheld by the Court of Appeal, doubtless some definitions will be given of what is really covered by it, so that if it is restricted, as it probably must be to some form of hydro-carbon, expert chemists may use their ingenuity in discovering some substance outside the pale of the hydro-carbon as limited by the courts, and by the aid of which the flashing process may be successfully performed.

THE ETEVE-HUMES PETROLEUM ENGINE FOR LAUNCHES.

THIS engine is of the vertical type with cylinder uppermost, having the crank shaft in line with the keel of the boat, and is provided with a fly-wheel 2 feet 6 inches in diameter. The floor space occupied is about 2 feet 6 inches square; oil tanks, mixers and other parts unconnected with the gearing are stowed under the seats or thwarts.

The cylinder is jacketed with a water chamber, through which water is constantly being pumped, entering at the lower end of the cylinder and passing away from the upper end; the reason for this apparent reversal of the water supply, that is, in not pumping the fresh water on to the hottest part of the metal, was to ensure the certainty of the water chamber being always full, the constant change secured in equal quantities for each stroke of the pump thereby counteracting any disadvantage that might otherwise arise from this method of supplying the fresh liquid.

To the top end of the cylinder are attached two valves, one to regulate the exhaust of the burnt products of each explosion which is worked from the eccentric, and the second acting automatically, furnishing the supply of petroleum spray.

The eccentric is carried on a separate shaft, and by means of toothed wheels is revolved at half the speed of the crank shaft; this shaft also actuates the air pump as well as carrying an arm which puts on the electric current when required to ignite a charge in the cylinder. The eccentric rod is connected to a slide rod which during a portion of the stroke presses and lifts another sliding rod, thus opening the exhaust valve and the returning piston frees the interior of the cylinder from spent gases.

The automatic valve for gas supply begins to work when the piston begins its forward stroke, but as soon as the compression takes place on the piston's return, the valve is closed, and on completion of the compression the charge is ignited by the spark from an induction coil, the explosion driving the piston forward, and the succession of processes repeating itself. There is consequently one ignition for every two revolutions of the main shaft.

The air pump, as mentioned above, is worked from the eccentric shaft, forcing the compressed air

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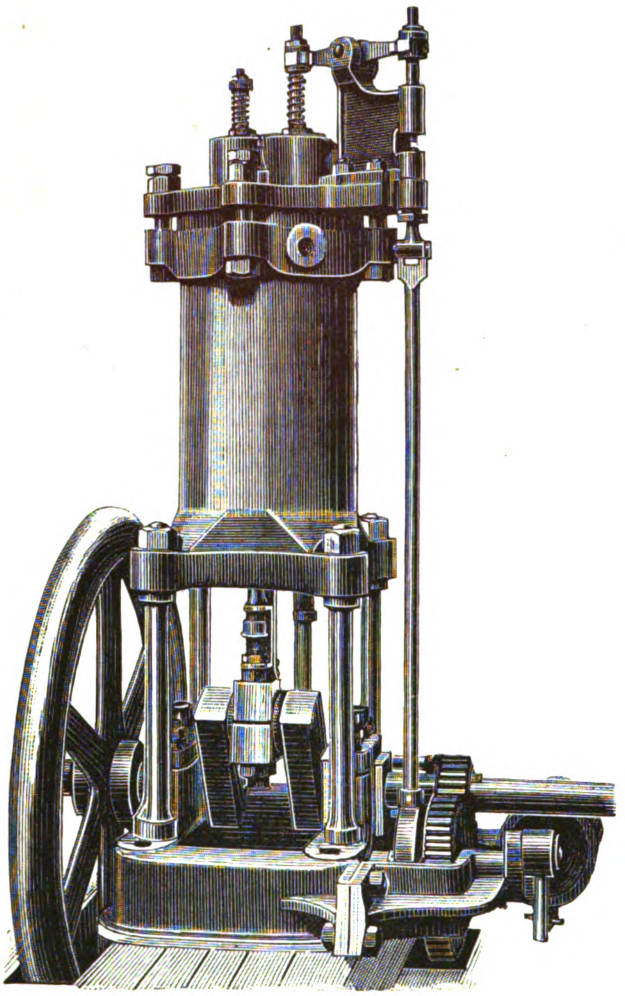
through a tube to the oil tank, passing a regulating valve which it is proposed to adjust by means of the engine governor; the air supply and the fine jet of petroleum are then mixed in a receptacle, again passing through a chamber filled with lengths of iron wire, and from thence proceeding to the cylinder cover to be admitted through the automatic valve when a charge is taken. The chamber filled with iron wire is to prevent any danger from back lash of the flame, which might perchance reach the mixing chamber and cause an explosion.



The power given out by the engine is about 3½ H.P. actual, with a consumption of about one quart per horse-power, costing, say, three-halfpence for oil.

The arrangements for lubrication appear to be satisfactory, and the device for reversing the engine is neatly and skilfully arranged.

Taking the engine as a whole, the makers have made immense strides in the improvement of every part of it during the last year, and the friction throughout the working parts has been reduced to a minimum.

The Electric Light at Eastbourne.—At the last meeting of the Eastbourne Town Council a recommendation was brought up from one of the committees to the effect that the electric light should be adopted throughout the whole of the new Town Hall (a sufficient number of gas brackets being provided in case of emergency), and that the architect should be requested to bring up an estimate and a report on the matter. Councillor Hillman asked whether the Brighton Town Council had not decided to abandon the electric light in the Pavilion. Possibly a little information on this subject might influence the council in regard to the method of lighting the new Town Hall. As no member of the council seemed to be in a position to answer the question, the matter was referred back to the committee.

NOTES.

Electric Lighting at the Edinburgh Exhibition.—A Correction.—By inadvertence we published last week an article, extracted from the *Times*, on the electric lighting machinery and apparatus at the Edinburgh Exhibition, under the heading of "Electric Lighting at the Liverpool Exhibition." As we have previously stated, the whole of the electric lighting at the Liverpool Exhibition is being carried out by the Liverpool Electric Supply Company, of which company Messrs. Holmes and Vaudray are the managing engineers.

Electric Lighting on Railways.—According to the *Engineer*, some engineers still speak of electric lighting as untrustworthy. One railway engineer recently refused to light an underground railway by this light, chiefly because of its uncertainty, but another railway engineer is not only lighting Paddington Station, one of the largest in London, but he is lighting all the signals by the same means, the strongest possible proof of the reliance some men put in electric lighting, and this even with an alternating current. An underground line is just the place where gas should not be used, but the engineer of the Mersey line laid great stress on the higher cost of the electric light. When railway signals are properly lighted by electricity they may be also worked by the same means.

Town Lighting by Electricity in Sweden.—The first city in Europe where electricity has been entirely substituted for gas for street lighting is the town of Hernösand, in Sweden, where the Thomson-Houston system has just been adopted. The motive power is water, which is very plentiful there, rendering the light cheaper than gas.

The Telephone in Swansea.—We understand that next week the Western Counties and South Wales Telephone Company will open a telephone exchange in Swansea, having secured convenient premises at the bottom of Wind Street in proximity to the docks and merchants' offices. There will be direct communication with Llanelly at once, and within a short time, the new company's wires will extend to Landore, Neath, Aberdare, and thence through Newport, we believe, to Bristol. The Swansea Commercial Exchange is intended to be open both night and day, Sundays excepted.

Telephonic Communication at Bath.—The Western Counties and South Wales Telephone Company having decided to open a telephone exchange in Bath, a trial line was erected last week between two well-known houses of business, and messages were conveyed to and fro with great success. The centre of the exchange will be situate in Union Street. Already many applications for membership have been received, and, by the opening date—definitely fixed for the 21st inst.—doubtless many other commercial men will take advantage of such a desirable means of inter-communication.

Mexican Telegraphs.—We gather from official reports that notable improvements have taken place in the management and working of the Mexican lines under the energetic control of the Director-General of Federal Telegraphs, Senor C. Saturnino Islas, ably assisted in his endeavours to improve the service by Senor C. Ortiz, the chief of the Central Office, and by Senor Carlos J. Bustamente, inspector of the 4th Department. The efforts of these gentlemen have been lately directed towards the improvement of communications between Paso del Norte on the United States frontier, and Vera Cruz on the Gulf of Mexico, a distance of about 1,836 miles, and they have succeeded in working between those two places in the most satisfactory manner. When one considers the great distances of uninhabited country the lines pass through, the difficulties of transport, the scarcity of skilled labour, and the severity of tropical storms, the fact that not only

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has good communication been established but has also been maintained, reflects great credit on those who have carried out the work. The average time occupied in the transmission of messages between Paso del Norte and Vera Cruz is about 50 minutes per message. The Mexican Government could not have made a better selection than Senor Islas as Director-General of Telegraphs, for it is certainly due to his zeal and energy that a general reform (and one much needed) has been effected throughout the whole of the Mexican telegraph system. He has had many difficulties to struggle with ; jealousies, want of money and material, inefficient operators, and the proverbial Spanish "manana," have all contributed to delay his work, but he has succeeded in overcoming most of the obstacles which hindered the efficient working and delayed the extension of the lines under his charge.

French Telegraphs.—The French papers state that Mons. Fribourg, director of construction in the Ministry of Posts and Telegraphs, has been appointed as Government Delegate to assist the Minister of Posts and Telegraphs before the Chamber of Deputies and the Senate in support of the Bill approving of the telegraph laws and tariffs drawn up at the Berlin Conference of September 17th, 1885.

Telegraph Instruments Wanted.—The Highland Railway Company advertises for tenders for telegraph instruments and fittings, to be lodged with the secretary, Mr. A. Dougall, company's offices, Inverness, by the 26th inst.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to June 12th, 1886, amounted to £265,000 against £355,000 received from April 1st to June 13th, 1885. The estimated receipts for the year 1886-7 are £1,730,000.

The International Cable Company.—According to the *Financial News* : "The International Cable Company, Limited, or their agents, are circulating in various cities on the Continent a circular letter, written in French, strongly recommending the enterprise to continental investors. According to this document the capital of the company is £1,000,000, 'of which £500,000 has already been subscribed in England, half by the Henley's Telegraph Company and half by the syndicate of Alfred Huth and others.' According to the same document, 'the banks which, after minute investigations of the merits of the enterprise and of the character of the persons connected with it, have undertaken to make the issue of shares in England and on the Continent are : Messrs. Dimsdale, Fowler & Co., of London ; Parr's Banking Company of Liverpool ; the Union Bank of Manchester, with its 36 branches ; Henry Burnay & Co., of Lisbon ; J. Matthieu et fils, of Brussels ; and Baron Oppenheim, of Cologne.' 'All these bankers,' we are told, 'are prepared to confirm the favourable statements made concerning the enterprise.' . . . . The names of the trustees (*commissaires*) are given as 'Sir Robert Fowler, Baronet, M.P., former Lord Mayor of London,' and 'Charles Seymour Grenfell, director of the London and County Bank,' while the names of the electrical engineers are given as 'Dr. Hopkinson, engineer of the Board of Trade and of Trinity House, and M. Massey, Windsor Castle, electrician of the royal palaces.' . . . . With this array of names it should not be difficult for the company to obtain in Belgium the £150,000 of subscriptions which the circular before us says must be subscribed firm before any issue is made (*on demande a la Belgique de souscrire ferme avant toute emission pour* £150,000). But it would be interesting to know why, if £500,000 has already been subscribed in England, 150,000 *must* be forthcoming from Belgium. According to a 'private and confidential' prospectus of the company, written in English, and from which, by-the-bye, the names of the directors are conspicuously absent, the first issue will only be of £650,000, or just the amount already reported to have been subscribed by the Henley Company and Mr. Huth, *plus* the amount asked from Belgium. Our Belgian friends and all intending investors should look into this matter carefully before investing, more particularly because the company's English prospectus sets forth that 'applicants for shares shall be deemed to have waived *all* rights under the 38th section of the Companies Acts, 1867,' rather an important waiver. It would also be interesting to know who the parties are behind the distinguished directors and engineers whose names are so temptingly paraded in the French prospectus. Were they in any way connected with the late A B C Cable Company, or with Mr. Otto Rochs, or with Messrs. Macpherson & Co. ? and why has it been deemed expedient to solicit subscriptions abroad before the floating of the company in England ?"

Alleged Libel on Mr. Hugh Watt.—Richard Fyfe, engineer, was charged at Westminster with writing and publishing a false and defamatory libel of and concerning Mr. Hugh Watt, merchant, of St. George's Road, S.W., and one of the members of Parliament for the city of Glasgow. The prosecutor was not in attendance, but his sworn information on which the prisoner had been remanded was read over by Mr. Safford, the chief clerk. It was to the effect that on March 20th last the prisoner was discharged from the employment of the Maxim-Weston Electric Company, Limited, of which Mr. Watt is the chairman of directors. Since his discharge the prisoner has written a number of most scurrilous letters, which had been sent to Mr. Watt. His friends had also received letters of a like character, reflecting upon him in various capacities as regarded his directorship and in his private life. He identified the writing of the matter alleged to be libellous as that of the defendant. Copies of the letters, with the words "to be published verbatim," "to be forwarded to your constituency, brother directors, shareholders," &c., were in the following terms : "H. Watt. Sir,—I was never kicked out of my house and my wife gone ; the brokers in charge of a house on the hire system. I am a gentleman—Richard Fyfe. . . . . You will very likely pay my claim in course. £62,500. Office boys."—Mr. D'Eyncourt remarked that he did not understand this.—The Chief Clerk : The suggestion, I believe, is, Sir, that shares were awarded to office boys to that amount. These letters were sent to Mr. Watt's brother directors.—Serjeant Edwards, who arrested the prisoner on the first occasion, stated that when in custody he said he could prove what he said, and that the prosecutor had written him a letter threatening him with penal servitude. Fyfe also told him that he went to Glasgow at the time of the last election, and was there for six weeks, at great expense to himself, assisting in Mr. Watt's candidature.—Dengate, one of the warrant officers, who took the prisoner in custody on Saturday night, at a public-house at Chelsea, where his wife had been followed, said that he made a statement to the effect that it was very foolish on his part to go away ; it was due to the fact that he went on the drink.—Mr. D'Eyncourt remanded the accused in custody for the attendance of the prosecutor.

Another Searcher Rewarded.—Mr. A. Moulds, residing in Upper Kent Street, Leicester, perceiving an escape of gas in one of the rooms in his house, took a light to search for it. The result was that a serious explosion occurred, the doors and windows were blown out into the street, the furniture wrecked, and the walls stripped of their coverings. Mr. Moulds was knocked down and severely shaken.

The Meaning of "Filament."—In some works on hydro-dynamics the word filament is applied to a jet of water. The scientific experts who were under examination during the recent incandescent lamp patent case may like to know this fact, as it contradicts the assertions of some of the plaintiffs' witnesses that the word is never used except with reference to something exceedingly fine.

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Patent Office Library.—The free library at the Patent Office, Southampton Buildings, will after July 1st be opened from 10 a.m. till 10 p.m.

Examination Papers.—We have perused the examination questions for 1886 in magnetism and electricity, set by the Science and Art Department, as well as those for telegraphy, electric lighting and transmission of power, and electrical instrument making, prepared for the students of the City and Guilds of London Institute. There has been an immense improvement in the electricity-magnetism papers during the last two years; all the examples in the Elementary and Advanced Grades are little problems, not mere stock questions. In telegraphy Mr. Preece tries to be very concise, but junior telegraphists must find it very difficult to answer the Ordinary Grade questions, the range of subjects being too wide to expect an answer to 10 out of 12. The other papers mentioned also show an advance generally upon those of previous years, Dr. Fleming now being examiner. That on electrical instrument making is the least satisfactory, and we should be inclined to say that the propounder of the questions had never worked as an instrument maker, for he does not bring out the niceties of the trade. Examiners should do their very utmost to set questions in the Ordinary Grade suitable to workmen and apprentices. In the Honours paper they may ask any questions however difficult, and especially questions which will show that the student, who is not supposed to be a mere workman, has read and understood electrical literature.

Ballaarat School of Mines.—The report for 1885 of the lecturer on electricity and magnetism at these schools, Mr. Henry Sutton, A.S.T.E., states that during the year satisfactory progress has been made, the students devoting a considerable amount of application to their work. The method of study has been somewhat modified during the past year. Students spending six months in the elementary theoretical portion of the subject and the easier branches of practical work, are then considered fit for trial in first stage examinations; if successful, they complete a course of six months at practical work, and another six months principally in the study of the applications and more advanced theory, which enables them, if successful, to pass the second stage. The practical work performed during the first half of the second stage year consists in the manufacture of electrical testing apparatus, which becomes the property of the student, and is used by him in his subsequent work. The final examination requires twelve months hard study and work before the student is considered fit to present for the school's certificate; so that it takes two years and six months for a student, if successful at every examination, to be considered qualified as an electrician. The lecturer on telegraphy, Mr. W. D. Campbell, reported that the attendance in his class had kept up very well during the year, 65 names appearing on the roll. The result, however, of the two examinations held, had been very disappointing, only four students having passed. This was unprecedented, and seemed to point to a raising of the standard by the examiners, which would have to be met by greater care, if possible, in preparing students; greater diligence on their part; increased facilities being offered for practice; and probably a longer period of tuition, before being allowed to present for examination. The increased difficulty of passing should not, however, deter students as there is likely to be an increased demand for operators, caused by the expansion of the telegraph system by the reduction in the price of telegrams.

Conversazione. — Prof. D. E. Hughes and Mrs. Hughes have invited the members of the Society of Telegraph-Engineers and Electricians, of which society the Professor is president, to a conversazione in the galleries of the Royal Institute of Painters in Water Colours, 191, Piccadilly, on Tuesday evening, the 29th inst.

New Chloride of Silver Battery.—Mr. Warren de la Rue, *Engineering* states, has arranged his chloride of silver battery in a new or dry form, which adapts it better for the purpose of maintaining small incandescence lamps alight. The cell consists of a flat glazed earthenware tray containing a sheet of silver foil on its floor. Dry powdered chloride of silver is spread over this plate, and a vegetable jelly is laid over that to support the zinc plate, which is the upper pole of the cell. This jelly is made by dissolving a solution of chloride of ammonium (2½ per cent. of the salt) in Ceylon moss or "Agar-agar." A pile of these cells makes a small convenient battery.

Electrical Boats for Service.—In the *Army and Navy Gazette* for the 12th inst. there commenced the first of a series of articles having the above title. The author is Mr. C. Sleeman (late R.N.), and we make the following extract from his paper:—"Insomuch as a great many of our men-of-war are being now provided with the electric light, and as it is intended to introduce this system of lighting throughout the service, the means for the recharging of accumulators is ready to hand, and thus many of our ships-of-war are pre-eminently adapted for the employment of electrical boats; while as, in addition, there is to be found at most of our naval ports machinery of the right description for executing the work of recharging, there really exists no adequate reason why, for once, the Admiralty should not take the initial step, by instituting experiments on a reasonable scale, to work into practical shape a new application that, as in the particular case under notice, offers every reasonable prospect of ultimately proving an immense boon and benefit to the service at large." We fear the writer does not understand the kind of machine which is always employed for charging accumulators or he would not say generally that the means (on board ship) are ready to hand.

Honours for an Electrician.—In recognition of the great advance exhibited in Mr. Lucius J. Phelps's method of communicating telegraphically with moving trains, the Franklin Institute has awarded to that gentleman the John Scott Medal and Prize. Some time since a special committee appointed for the purpose examined the system fully, as it is operated on the New York and New Haven Railroad, and upon their recommendation the award was made. Mr. Phelps has introduced numerous improvements by which he duplexes his line, thus adding greatly to its capacity.

A Heartless Inventor.—Mr. Hussey, of Menlo Park, has invented an electrical clock that runs without winding. The man who generally becomes thirsty about midnight, and invents an excuse to go down stairs by saying that he forgot to wind the clock, will not give a cordial welcome to the new timepiece.—*Norristown Herald.*

The Life of Incandescent Lamps. — Mr. James Swinburne finds that if lamps of 100 volts and 50 volts, of any makers, are both overrun on the same circuit at the same efficiency, the 100 volt lamp breaks first. With regard to the question of the life of lamps, Mr. Mordey shares the common belief that it is of the utmost importance that lamps should have long lives. He holds this opinion in spite of Mr. Preece's statement, that at present lamps last too long, and that it would be better to work them at a higher efficiency and with a shorter life.

High Tension Currents.—At Eastbourne, for nearly 3½ years, there have been two circuits running with 1,800 volts on them every evening, and during the whole of that time there has not been a single accident; and, with the exception of Mr. Henry M. Sayers, no one has yet received a shock. One evening this gentleman was making some experiments and managed to break the 1,800 volt circuit and put himself in the gap. Although knocked down he received no serious hurt.

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The Emission of Light.—Mr. Mortimer Evans thinks that the economy of light and the absence of heat emitted from an incandescent surface is solely due to the reflective efficiency of the surface itself, and not in any way to the material of which it is composed. Were we able, says Mr. Evans, to produce a perfectly reflecting carbon surface, or, indeed, a perfectly reflecting surface of any material capable of bearing the necessary temperature, I have little doubt but that an efficiency of 1½ or 2 watts per candle-power might be obtained, and this without any increase in the temperature or strain to the filament.

Rupture of Insulating Materials.—Mr. Mordey does not think that Prof. Fleming is right in supposing that the danger of rupture to insulating materials increases as the square of the electromotive force. Mr. Mordey's own experience in practical working has never revealed anything that would confirm such a supposition. We imagine not, for if our memory serves us aright, Prof. Ayrton has employed no less than 14,000 volts in testing some of Henley's patent ozokerited India-rubber core.

The Unseen Agent.—Sir David Salomons relates the following story, but does not guarantee the whole of the particulars as being accurate; but generally the facts are true :—There is a shop a few doors from the Inns of Court Hotel lighted by arc lamps. A man went to look into the window of the shop and was suddenly knocked down by some unseen agent; a policeman thereupon went to complain to the manager inside, but he was knocked over likewise. The reason of all the mischief was that the whole of the framing of the shop was of metal, also the area frame in front, and one of the arc lamp leads had somehow become connected with the framing.

Carbon Conductors in Glow Lamps.—Prof. Silvanus Thompson expresses astonishment that Mr. Preece should call the Bernstein carbon tube a "filament." Some one, says Mr. Thompson, at some time coined the term "filament," which may be convenient when one is speaking of a thin shred of tarred fibre, carbonised; but the name having been invented, we have all, like silly sheep, followed the fashion of calling all carbon conductors inside lamps "filaments," whether they really were or not.

The Bernstein Lamps.—Professor Ayrton thinks there is one great use for these low resistance lamps, and that is for temporary installations. A person wants to know, for instance, how many accumulators will be necessary for use with, say, half a dozen incandescent lamps of the ordinary type. The answer will probably be 26. But with the Bernstein lamp one could reply "four accumulators," and the Professor knows that such an answer will lead to the use of incandescent lamps for temporary installations.

The Regulation of Electric Currents.—At the meeting of the Society of Telegraph Engineers and Electricians on March 25th, Mr. Crompton said:—"I wish to point out that Profs. Forbes, Ayrton, and Silvanus Thompson have all fallen into the same error in ascribing the very perfect constant current regulation of various American systems of arc lighting, to regulating apparatus alone. They appear to have forgotten that in systems of arc lighting in series every arc light is a current regulator in itself, and this fact alone enormously facilitates the work of regulation of the governor or regulator common to the whole series system."

Wire Gauges.—Messrs. Walter T. Glover & Co. have recently improved their standard wire gauge to such an extent that we shall have something to say respecting it in our next issue.

Constant Currents.—During the discussion on Mr. Bernstein's paper, recently read before the Society of Telegraph Engineers and Electricians, some doubts were expressed as to the possibility of getting a constant current for electric lighting. Mr. Wright said that it was perfectly practicable, and that it was done at Brighton every day over three or four circuits extending some 8½ miles.

The Etève Petroleum Motor.—This engine, which is illustrated in our other columns, has been spoken of on several occasions in the REVIEW. We can, from our personal knowledge of its working, speak in very high terms of its utility, and our only wonder is that it has been so long in making its way in public favour.

Foreign Telegrams.—The Postmaster-General has given notice that on and from the 1st prox. the new regulations respecting foreign telegrams agreed upon at the International Telegraph Conference held at Berlin will come into force. The principal alterations are the following:—(*a*) The rules relating to European have been assimilated to those relating to extra-European code telegrams, the limit of length of a word in such messages being fixed at 10 letters, and words drawn from more than one of the authorised languages, viz.—English, French, German, Italian, Dutch, Portuguese, Spanish, and Latin being allowed. (*b*) The names of both the office and the country of destination will be counted in the address as one word each, whatever their length, provided they are written as single words by the sender, and are spelt in accordance with the official list. (*c*) The sender of a telegram will be able to have it repeated from office to office during transmission by paying an additional quarter-rate, instead of a half-rate as at present. (*d*) If the sender of a European telegram prepays a reply and the reply form is not used by the addressee, the amount prepaid for a reply will not be refunded as hitherto. (*e*) If the addressee of a telegram has it repeated and it then proves that only a portion of the telegram was inaccurately transmitted, only a proportionate part of the charges will be refunded. (*f*) The charges for any word or words omitted during the transmission of an extra-European telegram will be refunded. (*g*) The rates to several countries will be reduced as may be seen on reference to the Post Office Guide for July. The following are a few examples:—Russia, from 9d. to 6½d.; Spain, from 6d. to 4½d.; Italy, from 5d. to 4½d.; and India, from 4s. 7d. to 4s.

The Sonnblick Observatory.—What will be the highest observatory in Europe is now being erected on the Sonnblick, one of the heights of the Tyrolese Alps, 10,000 feet high. As there is great danger to the building from the terrific thunderstorms which rage round the summit, the observatory is protected not only by three lightning rods, but also by a lightning-proof fencing. The solitary resident observer who has chosen to exile himself from civilsation for the best part of the year is one of the miners permanently residing in the miners' house 8,000 feet above sea level, who is now undergoing a course of instruction in meteorology. But he will not be cut off entirely from intercourse with his kindred, for he will be able to keep up communication by telephone with the miners' house 2,000 feet below him, whence another telephone wire, 15 miles long, leads to Rauris. From the latter place, his daily record of observations will be telegraphed to Vienna and the scientific world generally.

Fire Damp Indicators.—We hope in our next issue to be able to describe an arrangement by which electric incandescent lamps may not only be employed for lighting purposes in mines, but may also be used as fire damp indicators. This, we think, has not hitherto been thought practicable.

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Primary Batteries for Incandescent Lighting.—The following letter from Mr. Allan V. Garratt to the New York *Electrical Review* is in reply to the letter of Messrs. Laing, Wharton and Down, which appeared in our last issue. Mr. Garratt says:—"I would say that the statements therein made are not sufficiently lucid to enable me to make an intelligent comparison of the cost of producing the incandescent light from primary batteries here in America, as compared with the cost in England. If I am to understand that the above-named gentlemen can charge a primary battery, which will maintain 12 to 15 eight candle-power lamps for 210 hours at a cost, for solution, of only one dollar and a quarter, and consume only 25 cents worth of zinc, I am sure that readers of the *Review* will be pleased to read a detailed description of how it is done. If, on the contrary, they can produce 8 candle-power of light for 210 hours at a cost of one dollar and a half, that is quite a different question. If Messrs. Laing, Wharton and Down will kindly publish in the *Review* a more detailed estimate of the cost of incandescent light by their system (stating the cost to their customers) I will be pleased to reciprocate by stating the price of light by the Volta Pavia system of the Chemical Electrical Light and Power Company of this city."

NEW COMPANIES REGISTERED.

Bradford Mutual Electric Lighting Company, Limited.—Capital, £10,000 in £5 shares. Objects: To enable the holders and tenants of premises abutting upon Kirkgate, Ivegate, New Tyrrell Street, Hustlergate, Albion Court, Queensgate, and other detached blocks of buildings in Bradford, to co-operate in using the electric light. Signatories (with 1 share each), Edward Pye, J. F. Schmidt, J. Mairom, Captain Oscar Haake, J. F. Read, F. T. Schmidt (electrician), R. C. Douglass (engineer), all of Bradford. Registered 10th inst. without articles of association by Messrs. Cann and Son, of 18 and 19, Fenchurch Street, as agents for Mr. F. McGowen, of Bradford.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Standard Time and Telephone Company, Limited.—A meeting of the shareholders in this company was held on the 5th inst., when an account was laid before them, showing the manner in which the winding up of the company has been conducted and its property disposed. The Registrar of Joint Stock Companies was duly informed of this meeting having taken place by the liquidator (Mr. Edgar Ray), on the 8th inst.

Cordner, Allen and Company, Limited.—At an extraordinary meeting of the shareholders in this company held at 20, Bucklersbury, on the 21st April, the following special resolutions were passed:—"In article 5, line 1, the word 'may' shall be substituted for the words 'shall not.'" "That to the extent of any shares of the company which shall become the property of the company, whether by purchase, or surrender, or forfeiture, or otherwise, the directors are authorised to issue in lieu thereof new shares having preference or guaranteed dividends, or profits, or any preference or priority, as regards the capital, dividends, or profits, or both, over the shares in the existing capital, or such other special rights, privileges, priorities, or advantages as the directors may think fit." "That the name of the company be changed to 'The Stanhope Company, Limited.'" These resolutions were confirmed on the 7th ult., and were registered 8th ult. A letter from the Board of Trade dated 14th May, and filed on the 22nd May, sanctions the change of name.

The last return of the company, made up to 13th January, was filed on the 24th March. The nominal capital is £30,000 in £5 shares, the whole of which are allotted. 2,000 shares are considered as fully paid and upon the remaining shares the full amount has been called up. The calls paid amount to £17,835, leaving £2,165 unpaid.

African Direct Telegraph Company, Limited.—The statutory return of this company, made up to the 22nd April, was filed on the 29th April. The nominal capital is £300,000 in £10 shares. 22,500 shares have been taken up and the full amount has been paid thereon.

International Cable Company, Limited.—The statutory return of this company was made up and filed on the 3rd ult. The nominal capital is £1,000,000 in £10 shares, but the only shares taken up are the seven subscribed for by the signatories to the memorandum and articles of association, and upon these no call has yet been made.

CITY NOTES, REPORTS, MEETINGS, &c.

Australasian Electric Light, Power, and Storage Company, Limited.

The fourth ordinary general meeting of this company was held on Friday last at the offices, 41, Coleman Street, Mr. Philip Falk presiding.

The Secretary (Mr. J. H. Duncan) having read the notice convening the meeting,

The Chairman, in moving the adoption of the report, said that his colleagues, as well as himself, confessed that they were disheartened and dissatisfied with the result of the working for the last twelve months. But they had reduced every possible expenditure on this side as well as in the colony, and, as they would see from the report for the last six months, the loss on their working had really been comparatively infinitesimal—namely, £111. The directors, however, had fully made up their minds that next time they met they would be able to show that, by having cut down the expenditure at both ends, and by fostering to the utmost extent their business, they would be able to secure some small profit. As far as he could see he believed they were turning the corner, and had times in Australia been more prosperous they would have had more public support. They had been anxious to sub-let, so to speak, to companies on the other side their patents, and so on—which, by the way, had recently greatly improved in value—but owing to the very adverse circumstances in the colonies for the last few years they had been unable to get people to entertain any proposal in that direction. If they could only wait a little longer he felt satisfied that such a period would arrive, and they would take advantage of it. As to the cause of their not having made greater progress, he could assign a good many reasons; but among others he would mention that they commenced life with perhaps too great expectations; they went to a new field, where they expected to make a very handsome thing out of the enterprise. The expenses at both ends, and more especially in the colonies, were very large; the work they did was of a tentative kind and the opposition they had to meet with on both sides was very great. The unwholesome competition they had had to contend against had also absorbed a large amount of their legitimate capital. As they were aware, the electric light companies here had suffered a good deal, and this circumstance had produced an unfavourable impression in the colonies, where there was a strong disinclination to be associated with anything that was not thoroughly established. The directors, however, in these circumstances had done all they could, and they would be encouraged to continue if they had the shareholders' approval. When times were prosperous among individuals there was a good deal of lavish expenditure, but when bad times came they had to curtail expenditure whereever it was possible. A similar experience had befallen this company, but it was utterly impossible unless they had had the power of divining the future that they could have acted differently. (A Shareholder: You were told to terminate the company.) That matter had been before them often enough. They had had work in hand which they were under the impression would secure them sufficient profit to enable them to pay their way and leave something for the proprietors. Unfortunately, however, in that expectation they had been disappointed, but that did not say that better times were not in store for them. If figures showed anything at all, they demonstrated beyond any doubt that they were now on the high road, at all events, to an

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improved state of things. They were partners in the Australian Electric Company, Melbourne, in which this company held 18,000 shares. That company had already completed their lighting stations, and were beginning to pay, and the Australasian Company would participate in their prosperity so far as regarded dividend. By the amalgamation with that company the Australasian Company had got rid of a formidable opponent. They had followed the advice of the committee of investigation that was appointed last year, and had reduced expenditure in every possible way. One of the members of the committee was Mr. Van Tromp, who had joined the board, and from whose assistance they had derived very great benefit. They had given that gentleman every opportunity to go into the affairs of the company. It was expected that if the proposed arrangement with the Edison Company were carried out, Major Flood Page would join the board, and he thought that would prove advantageous to them. The chairman then concluded by moving the adoption of the report and accounts.

Mr. Van Tromp, in seconding the motion, stated that he had joined the board under the conviction that very great mistakes had been made in the management, and that there had been a good deal of expenditure which need not have been incurred. But he did not come on the board with any impression that any member of it had done anything that was discreditable or dishonourable, and that opinion subsequent enquiries had confirmed. They thought that in carrying out the arrangement with the Edison Company they would, as it were, put on the crowning arch to the building. He would not advise any shareholder, even if he were offered 20s. a share with a liability equal to £1 on his shares—he would not advise him to sell. That was his view of the condition of the company. They confidently believed that they would be able to make the company a dividend-paying concern.

Messrs. Kisch, Morrison, and Pearson criticised favourably the policy of the directors, and the report was unanimously adopted.

Mr. Peek moved, and Mr. Morrison seconded, a resolution re-electing the whole of the directors, which was unanimously approved.

The Chairman, in returning thanks, assured the meeting that the board would do everything in its power to merit this renewal of confidence.

The auditors, Messrs. Deloitte, Dever, Griffith & Co., were re-elected, at a remuneration of twenty guineas.

An extraordinary general meeting followed.

The Chairman moved the first resolution, approving and ratifying an indenture between the Edison Electric Light Company, of the first part, Mr. Thomas Alva Edison, of Menlo Park, New Jersey, U.S., of the second part, and the Australasian Electric Light Company, of the third part.

Mr. J. J. Cater seconded the motion.

A shareholder asked for an explanation of the purport and advantages of the agreement referred to.

Mr. Duncan explained the main points of the amalgamation agreement.

On the motion of the Chairman, seconded by Mr. Cater, formal resolutions following upon the foregoing were put and carried.

The meeting then terminated in the usual manner.

The Consolidated Telephone Construction and Maintenance Company, Limited.

UNDER the presidency of Mr. C. L. W. Fitzgerald, the 5th ordinary general meeting of this company took place at Cannon Street Hotel, on Thursday last, 10th inst.

The secretary (Mr. Charles Curtoys) having read the notice convening the meeting, and the minutes of the 4th ordinary general meeting,

The Chairman (after the shareholders had agreed to take the report as read) said :—I hope I may be permitted to congratulate the shareholders on the improved aspect of the affairs of the company. When I look back two years, and consider the position that the company was in then, how really hopeless everything seemed, and really, as we all know, at that time, no money in the bank, debts everywhere; then when we came to examine this balance sheet in comparison with that of 1884, we have, I think, really the greatest cause for congratulation. Looking back to 1884, I see the gross profits for that year were £5,600, and of that £5,000 was absolutely compromised to the United. Therefore, the manufacturing profits for that year were only £600. This year you see the profits on manufacturing are £11,438. That item would be nearly £1,000 larger, but for a question which arose at the last moment on the part of the United's auditors, as to the price of certain instruments. I believe the United's Board is sitting to decide that very question just now, and I believe that question will be decided in our favour. We propose that that £1,000 should be written off against the goodwill and patent rights. The next point I think I should call your attention to is, the note as to the interest and dividends accrued on the holdings of the subsidiary companies. We have taken no credit for that, though I think already there is something like £1,400 due, the greater part of which will be paid by Australia, and the Edison-Gower-Bell will also pay part of that interest. That is a matter of considerable importance to us, because we are looking in the future to get dividends out of our subsidiary companies. Further, gentlemen, in the balance sheet you will find "plant and machinery" £3,097. You see we have written off a considerable sum off our machinery, but we have got now in the factory some more improved instruments from America. Now, our machinery is in an absolutely better condition than it was last year, and only at the same cost. Our stock of instruments—we have £3,303 worth. When I read to you an extract from a letter from one of the firms of Germany, which is perhaps at the tip-top of the electrical world—when they write to us on some of our samples which we submitted as follows :—"The tests which have been made with your instruments prove that they may be classed among the very best which have ever come under our notice"—and when I tell you that our stock is all of that character, you may imagine that I look with some degree of satisfaction on that communication. Now, gentlemen, there is the item of £11,590 owing by the subsidiary companies. That item includes a large sum owing us by the River Plate Telephone Company—£9,500. You will have seen from the report, that we have at last made terms of amalgamation with the opposition, and that to me is a very gratifying thing, because throughout this fighting the Consolidated has had to support the River Plate in cash, instruments, and stores, through thick and thin. On the other side of the balance sheet, I can assure you we have done everything possible to reduce the expenditure. I think you will find every item there shows a reduction on last year; but there are four items here which I should like to call attention to, which items I do not think will occur again next year. One is travelling expenses, £194; then there are expenses in connection with the Australian law suit, £167; commission on sale of River Plate debentures, £280; and accountants' special charges for preparing balance sheet, £40—in round numbers a total of £700. I only hope that in the next balance sheet those items will not be there; consequently, instead of the charges being £3,695, they will be under £3,000. The gross profit for the year amounts to £13,475. That profit has been collected from, I may say, all parts of the world; from some of our colonies; and I was extremely gratified, I may say, in getting two orders from America. I did not expect, I must confess, that I should go into the enemy's country in that way, but we *did*; and I hope we may get some more orders. Our business is slowly and steadily, but *surely*, extending, and I attribute that to the absolute goodness of our manufactures. I could show you heaps of testimonials on that head; and in addition to that we are really supplying the subsidiary countries in England with certain articles, magneto bells, and so on, which all means profit to us. We have started agencies in Madrid, Cadiz, and Naples, and I think I may say that these agencies will become very valuable outlets for our business. But I find the prices abroad too dear. Within the last six weeks the Government of Spain have asked if we would undertake to erect an exchange for them; a fact which looks as if they were recognising the superiority of our instruments. We have obtained, also, an absolute return of income tax. The next item is the law suit, which Col. Gouraud has started against the company, for his fees. We are advised that we have a very good defence indeed to that action up to within a very small portion of the claim which Colonel Gouraud brings against us. You will observe that the board ask you to permit us to assist the Edison-Gower-Bell Telephone Company in protecting the patent rights owned by that company in Belgium. This is a very important question. I cannot tell you how much the sum of money involved in it is. When I tell you that our greatest opponents, the manufacturing company over there, are turning out large numbers of instruments, every one of them being an infringement of the patent held by the Gower-Bell Telephone Company, you will realise that it is important that we should stop this infringement if possible. We shall not spend one penny more than is necessary, and shall only go into this matter if we feel our ground is very safe. Law is a very uncertain thing; but this particular Edison patent is the master patent in England and also in America. We are going to propose a resolution that you allow us to assist the Edison-Gower-Bell Telephone Company, but it will be on the understanding that we get half of whatever is made out of the transaction—bear half the cost, and take half the profit. Now, I think, I am coming to the most satisfactory part of the whole report—the amalgamation of the River Plate Telephone Company. I think I had better say as little as possible on that point, because we have only signed a preliminary agreement, therefore it is possible that I might say something which will do us no good. The next point which ought to be of equal benefit to the shareholders is the increased number of subscribers, and the rental of the subsidiary companies. You will find we (the Consolidated) hold £66,000 in debenture and preference shares of these three companies. Now, they are beginning to return us money, and if I mistake not this year will return us more money, especially if this River Plate amalgamation takes place. Indeed it is possible that in the future the large sum which stands here, which is even taken as nothing—£22,258—of those shares of the ordinary share capital of the subsidiary companies, may return to us some income. In Austria we shall have some return in course of time, and also in the River Plate, if the amalgamation takes place. If you will remember for a moment what that means—£66,000 of debentures—even if we only get 5 per cent. on that, the whole of our fixed charges would be paid by that return, so that we may divide every penny of profit. I have always had my eye upon the subsidiary companies, because I am sure they mean large returns. People do come for the telephone in a most marvellous way. If I return to the Austria report, I find that 18 months ago we had 600 subscribers only; we have now 1,373; and I may say that they are coming almost too rapidly for us in

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Austria, for we want capital to carry out the work. While I am on that point I would say that the Board of the Austrian Company propose issuing some 6 per cent. preference shares. If the shareholders of the Consolidated wish to assist the Austrian Company, and themselves, they will assist that Austrian board by taking some of these shares. As far as I am concerned, I and my father have already a considerable stake in the Austrian Company, and I am thinking of putting some more money into it. I think it is as good a thing as I have come across. I will now read the first resolution I have to propose: "That the statement of accounts and balance sheet, and the report of the directors, as now submitted to the meeting, be received and adopted; and that a final dividend of 2½ per cent. be paid, making, with the interim dividend previously paid, 5 per cent. for the year ending 31st March, 1886."

Sir Alexander Armstrong seconded.

Mr. Flenk: What is the probable cost of this litigation, and the probable result of that cost?

The Chairman: We have gone into this question considerably before bringing it under your notice. So far as we know, we *think* the probable cost will be about £2,000. The probable profit would mean many thousands of pounds, if we are successful. The Belgian infringers would have to pay us for the infringements in the past, if we are successful.

Mr. Flenk: Do I understand that our total contribution to the cost would be £2,000?

The Chairman: No, £1,000. The Edison-Gower-Bell Company of Europe would pay £1,000.

A Shareholder: May I ask whether our opponents in Belgium are a rich company; and whether we are likely to recover—whether they are worth powder and shot?—

The Chairman: I only wish we were as rich.

The Chairman then put the resolution for the adoption of the report, &c., which was agreed to.

The following resolution was then submitted by the chairman, seconded also by Sir Alexander Armstrong, and adopted: "That the directors be authorised to take such steps as they think desirable in connection with the Edison-Gower-Bell Company of Europe, for the protection of their patent rights in Belgium."

On the motion of the Chairman, seconded by Mr. John Taylor (one of the board), the following members of the board, who retired by rotation, were re-elected: Sir Alexander Armstrong, and Messrs. A. H. Baker and H. Grewing.

The auditors, Messrs. J. E. Griffiths and A. E. Green, having been duly proposed and seconded, were also re-elected.

Mr. Lloyd then proposed a vote of thanks to the chairman and the board, and referred to the admirable progress made by the company within the last two years. When they looked back, he thought they would be convinced that their success was not due to a fluke, but was really due to good management; and he thought that, under the circumstances, the board deserved their warmest thanks. The chairman had said that if things went on smoothly their dividends from the subsidiary companies would cover the fixed expenses of the Consolidated, and that, he thought, was very satisfactory. The organisation of their factory was such that they did not need to lock up any capital for working purposes, because payment followed rapidly on the work done.

The Chairman briefly replied, and the proceedings closed.

London Platino-Brazilian Telegraph Company, Limited.—The balance sheet and accounts for the past financial year are stated to have been made up on the same principle as those previously laid before the shareholders. The net revenue of the year, after providing for debenture interest and income tax, is £4,087 18s. 5d., and £1,068 4s. 11d. is brought in from the preceding year's account, making a total of £5,156 3s. 4d. to the credit of revenue account. The interim dividend of 1s. per share, paid on the 17th November, 1885, absorbed £1,917 8s., leaving therefore to be dealt with £3,238 15s. 4d., from which the directors propose to appropriate £150 in further reduction of the item of expenses of issue of the six per cent. debentures, and £1,917 8s. in payment of a final dividend of 1s. per share, making, with the interim dividend already paid, a distribution at the rate of 1 per cent. per annum; leaving a balance of £1,171 7s. 4d. to be carried forward against the amount due by the Uruguay Government. It is stated that the competition for South American traffic with the cables of the North Atlantic and of the West Coast of America Companies has continued during the past year, and has seriously diminished the revenue of the Western and Brazilian Company, in which this company is so largely interested.

Cable Rate Reductions.—Rates to come into force on July 1st.—Important reductions of tariff are to be made by the Eastern Telegraph Company not only to all countries in Europe, but also to India, Siam, Cochin-China, China, Manila, Japan, Australia, Tasmania, and New Zealand.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 11th were £2,194, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending June 11th were £2,756.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

5376. "Improvements in and relating to electric motors for the propulsion of boats and other purposes." A. RECKENZAUN. Dated May 1. 8d. The object of the present invention is to provide means whereby the direction of rotation of an electric motor or motors can be reversed, and at the same time to effect such reversal only at the moment when no current is passing through the armature or armatures of the propelling apparatus. The inventor effects the reversal or the displacement of the brushes relatively to the commutator by means of parallel bars capable of sliding to and fro in or on fixed slides. Upon these bars he places the brushes which will approach to or recede from the commutator according to the movement of the bars which are in plan at right angles to the axis of the armature. In order to prevent the possibility of an untimely reversal which often occurs in a hurry during an excitement on board an electric boat, car, or other vehicle propelled by electricity, or on anything driven by electric motors, he connects the said sliding bar or bars by suitable means with the lever of a switch which makes and breaks the main circuit between the motor and the generator. Either the switch lever is provided with an oblong hole, or the reversing bar or some intermediate link can be made to have sufficient back lash or freedom of movement so that the contact on the switch is broken whilst the brushes of the motor are at rest. By moving the switch handle still further the brushes are reversed, and finally by putting the lever to the end of its course contact is made in the switch to allow the current to flow when the rotation of the armature is the opposite of what it was with the switch lever in its original position. The return movement will of course bring the mechanism back to the first condition. The back lash of the mechanism and an intermediate spring or its equivalent determine the relative motion of the switch handle and the brushes.

6118. "An improved electrical system of sending and receiving signals, principally for domestic use, and apparatus to be used in connection therewith." H. P. F. JENSEN, B. W. WEBB, and J. JENSEN. Dated May 19. 8d. The principle of the invention is to enable a person sending a signal or call by the ordinary means applied for electric bells to receive back a confirmation signal, for instance, if one of the apparatus was fitted in room A and a similar one in room B, by turning the handle of apparatus in room A the apparatus in room B would keep on ringing or indicating until the handle of apparatus in room B was turned up thereby electrically replacing the handle on apparatus in room A.

6608. "Electrical indicator for alarms and other purposes." E. W. LANCASTER. Dated June 1. 8d. The inventor employs one or a pair of electro magnets at the ends or longitudinally of which he suspends by means of a spring a soft iron armature provided with a catch or bevelled stop piece projecting from it above, or in any suitable position about the armature is pivoted a disc shaped arm having connected to it at any angle a short crank which crank rests against the catch or stop piece on the armature and holds up the arm. The working is simply that of a current of electricity passing or circulating through the coils of the electro-magnet causes the armature to be attracted towards the said electro-magnets releasing the crank from the catch or stop piece and allowing the arm to fall to its lowest position indicating that the circuit had been completed. To replace the arm and crank to their positions behind the catch or stop piece a small rod is provided which slides behind the cranks having pins of suitable length to move the crank; on the rod being pressed lengthwise the crank is replaced as required.

7222. "Improvements in the manufacture of carbon for electric lamps and other electrical apparatus." J. Y. JOHNSON. (Communicated from abroad by La Société A. Chertemps et Cie., of Paris.) Dated June 13. 4d. According to this invention fluoride of baron and its derivatives are employed for dehydrating organic matter containing the elements of water in chemical combination with the object of obtaining carbon suitable for use in the construction of electrical apparatus, and in the manufacture of incandescent electric lamps in particular.

7583. "Improvements in means for signalling or telegraphing between railway trains, or between trains and stations, by induction." T. J. HANDFORD. (Communicated from abroad by T. A. Edison.) Dated June 22. 8d. Relates to the apparatus described in the number of the REVIEW for April 23rd.

7700. "Improvements in electro magnets and induction coils." C. D. ABEL. (Communicated from abroad by M. Lahaussois, of France.) Dated June 24. 8d. The soft iron core of an electro magnet or induction coil is, according to the present invention, constructed of such a configuration as to correspond with the aggregate form assumed by the gyrating particles of a whirlpool, &c., that is to say, it is made in the form approximating to that of two cones or conoids meeting at their apices, the poles of the core being consequently of considerably larger diameter than its middle.

8733. "Improvements in galvanic batteries." W. H. QUARTERMAN. Dated July 20. 8d. The object of the invention is to simplify the charging and discharging of galvanic batteries, so that they may be easily used for domestic lighting by persons having no previous knowledge of electricity, and enable them to

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charge and discharge the fluid, or fluids, in a quick and simple manner, without requiring the removal of covers or interference with connections. The ducts for conveying the fluid to the inner system of porous cells are formed in or under the bottom of the outer system of cells, and are carried up vertically at one end to the height required for the fluid to rise in the porous cells, and finished with a funnel shaped mouth, so that without removing the cover of the battery (to which the electrodes are fixed) the person charging the battery can see when the required quantity of fluid is poured in, or several batteries can be charged from reservoirs from which pipes with taps are arranged to discharge into the mouths of the ducts. The bottom of the said outer system of cells having the said ducts has taper holes leading into the ducts for charging the porous cells, and these holes are ground perfectly true and round, to one standard size. The outer system of cells has a hole at the bottom corner of each division to allow the fluid to flow throughout from cell to cell, and is charged by a duct at the same end as that from which the porous cells are charged. To discharge the battery a tap is provided for each fluid, one tap communicating with the ducts at the bottom of the outer cells, and the other tap with the outer cells themselves.

1886.

2080. "Improvements in electric switches." A. BERNSTEIN. Dated February 12. 8d. Relates to the switch described in the number of the REVIEW for April 2nd.

2282. "Improvements in apparatus for separating magnetic from non-magnetic substances." H. H. LAKE. (Communicated from abroad by H. Kessler, of Germany.) Dated February 16. 6d. Consists of an endless chain provided with a number of magnetic pins, which pass through and stir up the mass of material being acted on.

2317. "Improvements in electrical switches." C. BROWETT. Dated February 17. 8d. Relates to an improved form of electrical switch by which an electrical circuit may be opened or closed in a simple manner, by means of a cord, which may be pulled by hand in the same way as an ordinary bell-pull, the mechanism being so arranged that on the cord being pulled and released, the circuit is closed, if previously opened, and opened if previously closed.

2348. "Improvements in the manufacture of telegraph poles, columns, pillars, flag staffs, signal posts for railways, lamp posts, fence posts, and other posts; rolls or rollers for various purposes; chimneys, pipes for conveying liquids or gases, and other like tubular articles; railway and tramway sleepers, door steps, lintels, window sills, building blocks; and tanks, casks, and drums for containing liquid, semi-liquid and solid matters; and arms or insulator bars for telegraph poles and telegraph insulators; and in the method of and means or appliances for steadying telegraph poles and other poles and posts." D. WILSON. Dated February 17. 8d. Consists in part of the improvements on the apparatus described in a provisional specification filed by the inventor on May 15th, A.D. 1885, in application for Letters Patent, No. 5990, and the said improvements consist in using cement alone in place of concrete in the manufactures described in the said specification.

2456. "Improvements in holders for incandescent electric lamps." J. LEE. Dated February 19. 6d. The holder is constructed with a pair of arms which grip the terminal loops of the lamp and so give the greatest possible contact and security from disconnection.

2652. "Improvements in speaking telephone transmitters." W. C. TURNBULL. Dated February 23. 8d. The object of this invention is to provide a microphonic telephone transmitter having a large capacity for transmitting electrical undulations corresponding with the waves produced by sound, and at the same time, one which will not require special adjustment, but will always remain in good working condition.

2783. "Improvements in the construction of electro-motors for the propulsion of tramcars, electric locomotives, vehicles, and other purposes." A. J. JARMAN. Dated February 26. 8d. The object of the invention is to permit a suitably-constructed electromotor or motors of any type, size or kind in which the critical speed of the motor or motors is higher than the vehicle or machinery to be driven to transmit power with as little friction as possible, and to enable a reverse motion of such motor, vehicle, or machinery, without the employment of any of the usual reversing gear, such as bevil wheels, mitre gear, large or small crown racks, clutches, and the like, and without the well-known double brush system as applied to one collector or commutator of a single armature. The inventor fixes two armatures upon one axle or spindle and employs two sets of field magnets fitted to one common base plate, and the tops of the field magnets fitted to one common yoke, thus forming a compound electro-motor. A toothed or other suitable wheel is fitted upon any convenient part of the axle or spindle for communicating power to other wheels or machinery required to be set in motion. Each armature has a collector or commutator of its own, and a pair of conducting wire brushes or plates. These brushes or plates are so arranged that one armature can revolve in one direction when a current of electricity is allowed to circulate through it and its field magnets, and the brushes of the other armature are so arranged that it may revolve in the opposite direction when a current of electricity is allowed to circulate through it and its field magnets. The reverse motions are obtained by the brushes or plates being lifted off the collector or commutator of one armature by any suitable mechanical contrivance, while the brushes or plates of the other armature are placed upon its commutator or collector by the same mechanical contrivance.

CORRESPONDENCE.

Filaments of Deposited Carbon.

Our attention has been called to the recently published specification of Mr. Alexander Bernstein's patent (No. 13,036, of 1885), for "Improvements in the manufacture of carbons for incandescent lamps." The patented process would appear to consist in the decomposition of a carbon compound by the electric arc, with a resulting deposition of hard and dense carbon upon one of the electrodes. The patent also includes the use of a movable electrode, which being drawn away from the fixed electrode as the carbon is deposited, preserves the length of the arc constant, and permits of the deposition of uniform filaments of any desired length.

On the 10th November, 1882, a patent (No. 5,373, of 1882), was taken out by ourselves in conjunction with Mr. J. M. Boullon for "Improvements in electric lamps or lighting apparatus, and in the manufacture of light-emitting conductors for the same," in the specification of which we describe a process for the preparation of carbon filaments by the decomposition of a carbon compound by electricity and the resulting deposition of carbon upon one of the electrodes. We say :—"We take a suitable gas or vapour and subject it, as hereinafter described, to the action of the electric spark, which may be produced by any suitable generator of high-tension electricity. For this purpose we provide a globular, or other suitably shaped vessel of glass, in which we insert metallic conductors or electrodes. . . . . In some cases carbonaceous gas or vapour, such as marsh gas or coal gas, is introduced into the glass vessel, and is decomposed by the passage of electric sparks through the same. A slight deposit of carbon takes place upon the end of one of the electrodes, which deposit is gradually built up by means of a rapid succession or continuous flow of sparks, and a bridge of carbon is thus formed, so that the space separating the said metallic electrodes, between which the spark passes, is completely arched over. This bridge forms the filament to be used as the light-emitting conductor."

The advantage of using a movable electrode, for the preservation of a uniform arc and the production of filaments of uniform substance, and of greater length than it would be possible to prepare with fixed electrodes, early presented itself to us, and we therefore say in our specification :—"We find it advantageous to make the said filaments in a separate vessel, and to insert them and their electrodes afterwards within the lamp or lamps of which they are to form a part. In preparing our filaments to be used in this manner, we pass the electric sparks between electrodes of highly purified graphite. . . . . The filaments so formed we attach to electrodes in any convenient manner, and insert in . . . . vessels of glass in the usual way." We have in our possession at the present time a spiral filament 9 inches long, made by us three years ago with the aid of a movable electrode; and we may say that, except in our earliest experiments, all our filaments have been made in this way.

The apparatus figured by Mr. Bernstein in his specification would seem only capable of producing straight filaments, whereas the apparatus we have ourselves been in the habit of using will produce filaments of any degree of complexity of figure.

Alfred W. Soward.
I. Probert.

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Telephone Matters in America.

The United States suit against the Bell telephone patent is, in my opinion, likely to remain on the calendar of the court an untried case for years to come —or just so long as the astute counsel of the Bell Company may please to keep it there. In a former letter I wrote that the Bell Company would demur to the jurisdiction of the court, and it has now done so. June 1st was set down by the court for the hearing of the case; the Bell Company did not file any answer to the bill of complaint, but simply demurred to the jurisdiction of the court, and no time has been set for hearing the argument for the demurrer, and should the court overrule the démurrer, the Bell Company will, I think, take an appeal to the United States Circuit Court, and in case an adverse decision thereon, then to the United States Supreme Court, where it may be heard early in 1887.

The suit brought by the Bell Company against the National Telephone Company in New Orleans which was argued in February last, has been decided in favour of the Bell Company—just as it should be—for the simple reason that the instruments used by the National Company were simply Bell receivers and Edison transmitters; the principal point of defence was that Bell was not the first inventor of the telephone, and that his patent therefore was void. The fact is Bell's counsel are too strong for any counsel yet brought against them, and I do not think any counsel can be brought who will be able to contend *scientifically* against them. Bell will be considered by his admirers to be the inventor of the telephone, until an instrument is made according to the description given by Bourseul of his telephone in 1854; and I am happy to say that I have unearthed the *original publication* signed "*C. Bourseul*," *Paris*, 1854, preceded by remarks of the editor of the paper. The references about M. Bourseul by the late M. Du Moncel and myself are not correct.

I have had made an instrument in exact conformity with Bourseul's description, and it transmits and repeats articulate speech perfectly well.

Count Du Moncel published in *La Lumiére Electrique*, of November 24th, 1883, over his own signature, "If we agree to call the true inventor that man who is the first to conceive clearly a new idea, and who tells us how this idea can be carried into practice, then the telephone was invented in 1854 by Charles Bourseul, a Frenchman, at that time a soldier in the French army in Africa."

W. C. Barney.

Washington, *June 4th*, 1886.

Schanschieff's Battery.

A criticism such as that by "A Maker of Primary Batteries" in your last issue is welcome to every honest inventor, and I have to thank your correspondent for his remarks. Faults honestly pointed out help an inventor, who is thereby spurred on to attain perfection, if possible.

I will deal with the two points raised by "A Maker of Primary Batteries" in their inverse order :—

1st. Deterioration of terminals and connections. If my exciting solution be spilt over the terminals in ordinary use the result is that the metal becomes amalgamated with mercury. To obviate this I now employ two methods. In some forms of the battery (hermetic and so on) I use iron terminals; in the batteries with open cells I use platinised terminals and connecting strips, completing the protection by varnishing when connected up.

2nd. The cost of work. In order to prove the working cost of my batteries, I will compare it with that of bichromate cells. The best form of the latter is said to be that in which chromic acid is used. Taking the wholesale price of this as 6d. per lb., the gallon of solution will cost about 1s. 6d. The price of my exciting liquid wholesale is 4s. 6d. per gallon, from the cost of which has to be deducted the value of the residue which I repurchase at 1s. 4d. per lb. According to the degree to which the liquid is worked out so will be the return from the residue deposited—ordinarily from 26 to 30 ozs. per gallon—value from 2s. 2d. to 2s. 6d.

In order to make my calculations perfectly plain and above board, I will take the figures given by M. Criquebeuf in the diagram prepared in the laboratory of M. Hospitalier, to which you refer in another part of your last number. The battery he tested was one of eight cells, each containing three-quarters of a pint of my exciting liquid, or six pints in all; this discharged a current of 0·8 ampère under a pressure of 11·25 volts at the beginning, and of 9 volts after eight hours' consecutive work; the mean E.M.F. I will take as 10·125 volts; the cost of the liquid (six pints at 2s. 4d. per gallon) being 1s. 9d.

A similar battery charged with chromic acid solution will develop 13·5 volts and give 1 ampère for not more than two hours, the cost of the charge at 1s. 6d. per gallon being 1s. 1½d.

I append a table showing these results :—

Battery.	Volts.	Amp.	Hours.	Total work in watts.	Cost of charge.	Cost per watt.	Cost per C.P.
					s. d.	d.	d.
Chromic acid...	13·5	1	2	27	1 1½	0·5	1·5
Schanschieff's	10·125	0·8	8	64·8	1 9	0·323	0·975

I have seen the working cost of bi-chromate batteries given by makers at one farthing per hour per lamp C.P. not stated. I would it were possible. Very probably a battery of large dimensions may work more economically than is shown above, but on the other hand I believe that under the same conditions my battery will show still better. My invention being so new, I have not had time or opportunity to have a battery on a large scale authoritatively tested: my own figures I prefer not to quote, for inventors are proverbially sanguine in judging their inventions. In the data of work of chromic acid I have calculated approximately, rather over-stating its capabilities, I believe, whilst as regards my battery I give the exact figures furnished by a high authority under a test which I personally consider severe.

A. Schanschieff.

June 15th, 1886.

[We presume Mr. Schanschieff, in giving the price of his liquid as 2s. 4d. per gallon, has made allowance for the value of the residue, as in the previous paragraph he quotes 4s. 6d.—EDS. ELEC. REV.]

A Hint to Correspondents.

I notice in this week's REVIEW a protest by a correspondent signing himself "Telephonist," against the adoption of his *nom de plume* by another writer, whose opinions happen to be quite in opposition to his own.

May I take this opportunity of suggesting to correspondents that it would be wiser for them in most cases to write always over their own name.

I do not say that circumstances may not arise under which, while it would be for the general advantage that a certain letter should be written or certain facts made known, it would be unfair to the writer that his name should be disclosed; but I think in a scientific paper such cases would be rare; and meanwhile the *nom de plume* is too often made to cover either spiteful attack or inaccurate statement.

I think that in the majority of cases where letters are written for insertion in the columns of a scientific journal, the fact that the writer would not wish his name to appear, should be a sufficient reason for not writing.

If the fact that everyone will know who is responsible for certain statements, or who is the writer of certain paragraphs, causes writers to be more careful as to what they write, the result can hardly be but beneficial; and on the other hand, if a man has anything to say worth printing, surely it should be to his advantage to get the credit of it himself.

Sydney F. Walker.

Cardiff, *June 14th*, 1886.

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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 448.

EXTRACTING METAL BY ELECTRICITY.

IN another column will be found a communication which has been forwarded to us for publication in reference to the proposed operations of a company formed for the purpose of working on an extended scale upon the extraction of the pure metal from waste tin cuttings. If a method has really been devised by which this object can be thoroughly effected, there is an enormous source of profit open to the promoters of the scheme. But we cannot let the matter go before our readers without relating a little of our own experience in this direction.

Some eight or ten years ago, for a period of several months, we assisted in extensive operations for recovering the tin from waste tin cuttings by means of electricity. These experiments were conducted near the Caledonian Road, quite close to King's Cross, and many tons of waste metal were operated upon. The plant consisted of two large tanks of rectangular shape, about 6 feet by 4 feet, with a depth of 16 feet. Pulleys or rollers were placed at each end, top and bottom, and over these passed endless chains. At a distance of two feet or so apart, brass rods were attached to these chains, and on the rods was slung the scrap tin plate from which it was desired to extract the tin in the form of black oxide, leaving the iron clean. A continuous series of rods containing scrap tin plate was therefore passing into and out of the bath until the tin had been cleared off. Each rod was then emptied of its load and a fresh supply put on. The dynamos employed were of the old Gramme electro-plating type, and were three in number. They were used singly, by twos, in series and parallel, and by threes in the same manner. For a time the operations would go smoothly enough, and then a complete change occurred, and the result was anything but satisfactory. The solution of the bath, having to be kept at a moderately high temperature, gave off fumes which oxidised the rods upon which the scrap tin plate was hung, and they were perpetually being cleaned. Many were the suggestions made and devices employed to eliminate bad contacts, but without avail, and after many months of hard work, and the expenditure of much money, the attempt was abandoned as a failure.

It must not be supposed, however, that no satisfactory results were ever obtained. Several tons of metal were actually thrown out, the surface of which was completely denuded of tin. Great efforts were made to get rid of the iron, which was of course of most excellent quality, but in no instance do we remember a purchase being made; in fact, iron founders refused to use it at any price, asserting that the metal was still impregnated with tin and that it could only be rendered perfectly free by furnace heating. The cost of working far exceeded the value of the products obtained; and thus ended an enterprise which was pluckily sustained for a considerable time in the hope that obstacles apparently insurmountable would be overcome.

The projected operations of the Electro Metal Extracting Company appear to us to be of precisely the same character as those which we witnessed and assisted in. It is possible that the difficulties which existed ten years ago have been again encountered, and this time surmounted. We have simply related our own experience for what it may be worth. We have not yet had the opportunity of inspecting the plant of the company, and therefore cannot say in what details it differs from that before described. We are not imbued with the enthusiasm with which possibly a direct interest in the concern has inspired our contributor; but, in justice to a new project which, on the face of it does not necessarily appear doomed to failure, we must reserve our judgment until data be forthcoming which will enable us to give a definite opinion on its prospects. That an undertaking of the kind may be practically carried out with success we do not doubt, but it remains to be seen at what cost. It is easy to estimate upon paper the working cost and the profits which will accrue to the shareholders in such a concern: calculations upon a theoretical basis declared that the unfortunate undertaking of which we have already spoken was a splendid thing for those who chose to invest, but in actual working on a moderately large scale it was quite different. "Samples" are to be seen at the company's office; but this fact of itself does not possess much value as a proof of the genuineness of the undertaking. We shall be glad to learn that the company's operations are proving successful, for the amount of work waiting to be done in this field is astonishingly great.

Since writing the above remarks we have received samples showing waste tin cutting before and after treatment, and also samples of the pure tin extracts, the analysis of which is said to show 99·2 per cent. These extracts are of a bright colour and have somewhat the appearance of tin amalgam: we should like to know whether they are deposited in this form, or are obtained from the oxide.

AN ELECTRIC LIGHT FIRE-DAMP INDICATOR.

THE Royal Commission on Accidents in Mines * points out in its recently issued report a serious objection to the use of the electric light in mines, notwithstanding its many other great advantages, in that the light of an incandescent lamp being produced within a vacuum cannot admit of any device for the indication of fire-damp, such as is employed in the Davy for example. This difficulty was experienced by one of the inventors of the apparatus we are about to describe in the course

* See ELECTRICAL REVIEW April 16th, 1886, p. 341.

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of an installation of the electric light in the Lofthouse pit, Wyke, Yorks, in the summer of 1885, and a series of experiments have since been carried out with the object of devising a method of making the electric light an indicator of fire-damp.

The apparatus placed before the Physical Society at the meeting of Saturday the 12th inst., is the outcome of the work of Messrs. Walter Emmott and William Ackroyd. It consists of two incandescent lamps, one with white glass and the other with red, and other necessary adjuncts, such that in an ordinary atmosphere the white incandescent lamp alone shines, but in fire-damp the white lamp goes out and the red one begins to emit its light. This is effected as follows :—A porous pot of unglazed hard baked porcelain is joined by air-tight connections to a tube, a portion of which is represented by T, T[1], fig. 1. This tube is of such an internal diameter that it will readily admit of being sealed with a small quantity of mercury, Hg. A platinum wire runs the whole length of the tube, and is connected with one of the poles of the battery, B, or other source

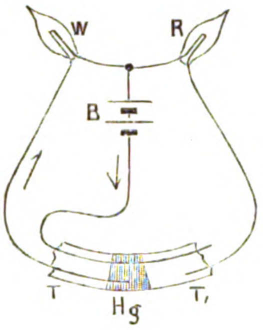


FIG. 1.

of electricity. Two other platinum wires in the tube run parallel with this for part of the way, as in fig. 1, and each is connected with a lamp. The lamps, W and R are joined and a branch wire connects them to the other pole of the battery. In fig. 1 the current is represented as flowing through W; when from diffusion in an atmosphere of fire-damp, the conducting plug, Hg, is driven up to T[1] the current will flow through R, and

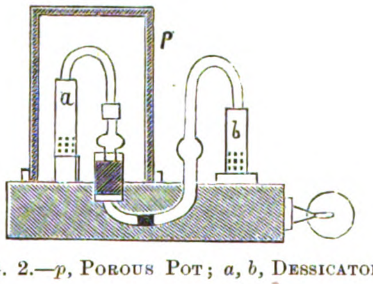


FIG. 2.—*p*, POROUS POT; *a*, *b*, DESSICATORS.

the red light may then be taken to indicate the presence of fire-damp. The wires being within the tube one or other of the lamps must always be shining so long as there is a current, whether the apparatus be in an atmosphere of fire-damp, choke-damp, or air; and to prevent the mercury being driven out of the tube by too much pressure, bulbs are arranged on either side, as in fig. 2, which presents a diagrammatic view of the apparatus.

The inventors find an internal diameter of tubing of about 3 mm. best adapted for ensuring easy mobility of the mercury. The presence of the wires within the tube has interfered with the perfection of the seal; this, however, has been overcome by the introduction of a little concentrated sulphuric acid, which also serves the purpose of preventing sparking and of lubricating the interior. The use of sulphuric acid necessitates the addition of dessicators, *a* and *b* (fig. 2), to each end of the tube, but in cases where it has been found advisable not to use sulphuric acid both the acid and the dessicators have been dispensed with by slightly modifying the arrangement of the wires at the lower part of the tube.

With this form of apparatus one can readily detect the presence of 5 per cent. of coal gas in a mixture of this gas with air, and with a mercury seal of less weight and closer proximity of the wires at T and T[1] (fig. 1), it

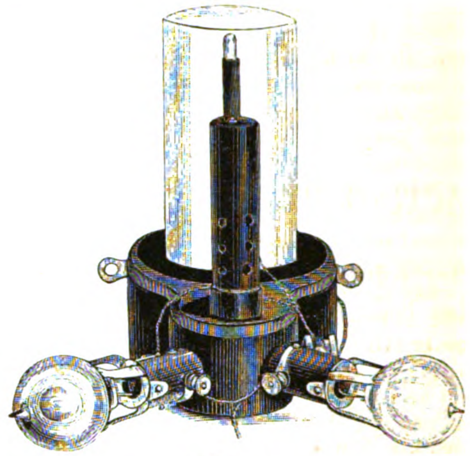


FIG. 3.

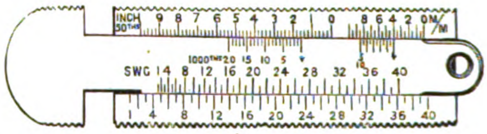
appears possible to get any required degree of sensitiveness.

Fig. 3 is a view of the apparatus about one-third full size.

STANDARD WIRE GAUGES.

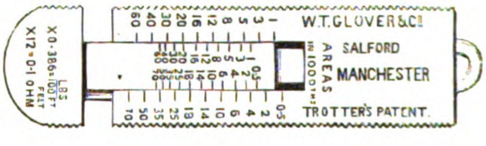
IN February of last year we brought under the notice of our readers a new wire gauge, based on the English standard sizes as fixed by the Act of 1883, and we revert to it again in order to mention several valuable improvements which have been effected in it and which render it of much greater value to electricians.

In its improved form the gauge will register the legal number of any wire between No. 1 and No. 40, S.W.G. (standard wire gauge), formerly it only read up to No. 6.



ACTUAL SIZE SHOWING S.W.G. INCH AND MM. SCALES.

In addition to this very valuable extension the area scale by which the current suitable for any size of copper wire can be calculated has been enlarged, and, whereas it only registered the area in thousandths of a square inch up to ·030 square inch it now gives them up to ·070 of a square inch. We illustrate this scale of areas and draw special attention to it on account of its usefulness for calculation.



ACTUAL SIZE SHOWING THE AREA SCALE.

In the first place, if the current be taken as 1,000 ampères to a square inch of copper, then this scale of areas may be taken as a scale of ampères direct, but if it be decided to transmit at the rate of 2,000 ampères to the square inch, then all that is necessary is to multiply the area by 2. Again, if the area figures be multiplied by 0·4 (more accurately 0·0386) it will give the weight in lbs. per 100 feet of the wire measured, while by multiplying the area by 12 we have the length in feet of copper wire having a resistance of one

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tenth of an ohm. By multiplying the area figures by 0·323 we get Sir William Thomson's rule of 0·5 ampère to a square millimetre. Again, multiplying by 0·0575 we get horse-power lost per mile with 1,000 ampères to the square inch. 42·8 divided by the area gives the resistances in ohms per mile, while the area multiplied by 20·35 = lbs. per mile. In use all that it is necessary to bear in mind is, that when any two numbers of the same name *coincide* these indicate the reading. Our illustrations will show what we mean; the S.W.G. numbers most nearly coinciding are 8, while on the area scale neither 18 nor 20 are quite opposite; the area of the wire supposed to have been measured is ·019 square inch. Very little practice will suffice to make its method of working clear.

A spring has been added in order to keep it steady when once fixed, and also to prevent its working loose.

These considerations seem to point to this little instrument as one likely to supply a want of electricians generally, as anything that saves time and facilitates prompt and accurate calculations cannot be other than of the utmost value in these days of high pressure. We cannot but compliment the inventor, Mr. A. P. Trotter, as the gauge is both novel and useful. It has been brought out by Messrs. Walter T. Glover & Co.

ELECTRICITY AND MANUFACTURES.

[A COMMUNICATION.]

HE would indeed have been considered a very bold man or a fanatic who but five or six years ago had expressed an opinion as to the future position of electricity, as relating to its actual attainments as exemplified in the year of grace 1886. But in this as in most other matters there is more surprise in practice than in theory. The electric light is now carried into the workshops of our land, and by its aid no skulking is possible, as it shows up all the dark corners, and also enables night to be changed into day, thus causing colours to be manufactured with ease, and giving the operatives of our factories a far healthier atmosphere to breathe.

Electricity also adds to our comforts in various ways, and few, if any, having once experienced its advantages are willing to set it aside. Its development has also occurred at a period in our national history when our manufactures had sunk to a low ebb, until it has opened up a source of employment for capital and labour, which is increasing and is destined to become of considerable magnitude. There are really few persons, even of those classes who should have known better, who are acquainted with the present position of electricity in Great Britain; fewer still know anything of what it is accomplishing abroad. Everyone knows it is used for lighting purposes and for electroplating, and in some few instances for the purpose of propulsion; but for other purposes their knowledge is exceedingly limited. The adaptation of electricity to the requirements of mankind would amply repay an investigation, but this is too large an undertaking for our limited space, although we may very probably refer to this in some future article.

The refining of copper in Great Britain has within the last few years created quite a new industry which is being rapidly developed; the electric current is also applied for making ozone, for bleaching and dyeing purposes, for refining sugar, for removing and preventing scale in boilers, and for refining oils, for encouraging vegetable growth, for all the ills and ailments of mankind, and a variety of other purposes; also for electrotyping purposes, rendering it possible to lay on any metallic surface upon drawing room furniture or delicate lace and ferns, as well as for the deposition of copper upon hydraulic rams, screw propellers, &c. These are what we may see any day in our own works. In America there is a yet wider application—it is employed there to catch thieves, to kill animals for food, or animals which are vermin, also for tanning purposes, and in the skinning of animals without injury to the hides, but the most recent application there is the production of alumina by its agency.

Having mentioned a wide field of operations we have now under our notice a further extension. The Electro Metal Extracting, Refining, and Plating Company, Limited, of Finsbury Chambers, 76, Finsbury Pavement, London, E.C., is formed with a capital of £50,000, in £1 shares, to extract and recover the tin from waste tin cuttings, of which electro process the company has acquired the sole rights and monopoly. The company is going to lay down plant in London (now being proceeded with), Wolverhampton, Birmingham, Swansea, Truro, Liverpool, and Glasgow, capable of dealing with a minimum quantity of 10,000 tons per year, or not one-third of the total available quantity of waste tin cuttings, which as waste material can be had for from 2s. to 5s. per ton delivered at the company's works. It seems that by the company's electro process every 20 tons of waste tin cuttings treated yield one ton of pure tin (chemically pure), worth £95 to £100 per ton, and when the cuttings are thus stripped of the tin there remain 19 tons of black charcoal iron scrap, worth 40s per ton more, or say £38—in all £133, from every 20 tons of tin cuttings. The company allows £54 for the cost of tin cuttings and the whole cost of working operations upon the quantity, which leaves a net profit of £79 for every 20 tons waste tin cuttings. It is not necessary to show how very profitable such working would be for even 10,000 tons.

The electro process of this company is as follows:—Powerful dynamos of approved make, giving suitable E.M.F., generate the requisite current, which is passed through a series of 20 baths containing suitable solutions, and the waste tin cuttings are placed therein and connected to the positive pole of the dynamo; suitable arrangements are made for "receiving" the valuable metal (tin), and after being washed this is further refined and made ready for the market, where it commands the highest price (£100 per ton).

The company is also laying down plant for galvanising iron goods by their electro process, the sole rights and monopolies of which it has also acquired. The advantages of this electro zinc process are, not an ounce of metal is wasted, no heat is applied, the deposit of zinc can be regulated to any desired thickness, and the fibre or tensile strength of the article galvanised is not affected, no acid being used, whilst the cost of the process effects, it is claimed, a saving of 30s. per ton of iron goods "galvanised," and it leaves a smooth surface—not lumpy and irregular. The company proposes to treat 20,000 tons of iron goods per year, and will grant licenses to the galvanising trade.

The electro process herein referred to enables the company to treat the immense quantities of mining tailings, mining refuse, and slag, which lie accumulated in heaps of hundreds of thousands of tons on the banks of disused mines as well as working mines, and to recover from such gold, silver, copper, and tin. This alone is an enterprise worthy of attention, as the "waste stuff" when worked by the primitive appliances of former days was incapable of being treated, although known to be rich in these valuable metals. It is probable, therefore, we may witness a resuscitation of "disused" mines, and great activity amongst those now paying no dividend. The treatment of refractory ores by the electro process of this company is also within its objects, and thus it brings before its shareholders a most extensive field of operations.

Samples of waste tin cuttings before and after treatment, and showing the tin recovered, can be seen at the company's offices in London as above named.

Enough has been said by us in this article to show that electricity in our manufactures is extending, and that it is destined to become an important factor in British industries.

[Some remarks anent the particular use of electricity dealt with in this article may be found in our leading columns.—EDS. ELEC. REV.]

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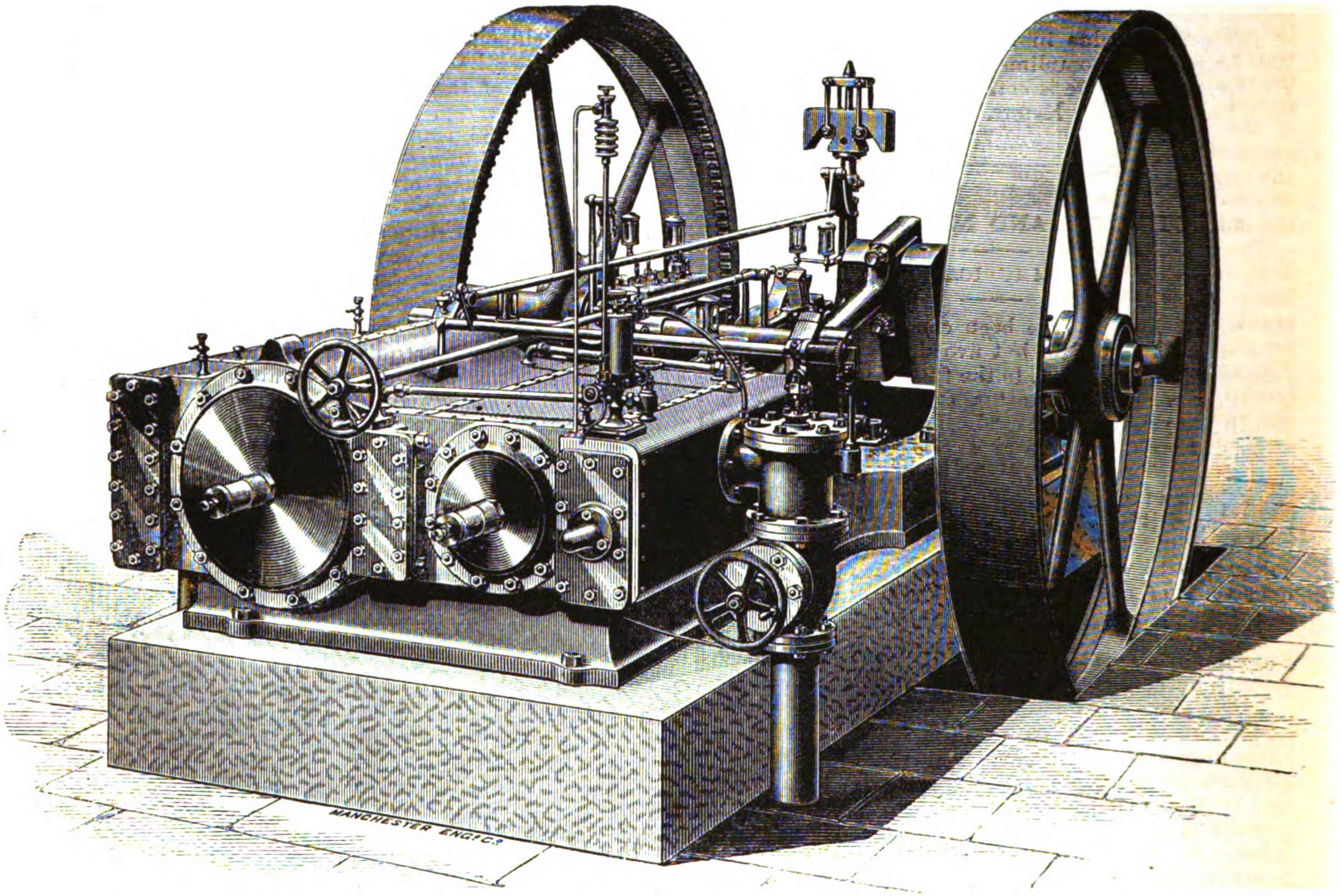
ELECTRIC LIGHTING AT THE COLONIAL AND INDIAN EXHIBITION.

THE explanation of the broad distinction which is observable between the electric lighting arrangements of the Inventions Exhibition and those of the present one, is to be found in the fact that while the whole of the machinery and apparatus last year were exhibits, this year the matter has been dealt with as an accessory on the same footing as the music and similar attractions. There is not to be found, therefore, in the present exhibition a large number of different systems competing, but the Executive Committee has made arrangements with certain firms to supply the necessary plant for the lighting of the buildings and grounds. As to the buildings, the work has been pretty evenly divided between the following four companies: the Anglo-American Brush Corporation, Messrs. R. E. Crompton & Co., the Edison and Swan United Company, and the Pilsen-Joel Company. The machines for these services are in the old electric light shed, and are all driven by the engines supplied by Messrs. Davey, Paxman & Co. In the illumination of the grounds and fountains a complete change has been made, and this work, which last year was performed by Messrs. Siemens, is now allotted to Messrs. W. and J. Galloway, of Manchester, whose engines and boilers have been familiar objects in former exhibitions, but who now for the first time make their appearance as electric light contractors. In the first place this firm took over the whole of the plant which was in use for this purpose last year, and the three Siemens dynamos and three Goodfellow and Matthews high speed engines occupy their old place in the Western Quadrant near the Conservatory standing idle, though ready for use in case of an emergency. Adjoining the disused machinery Messrs. Galloway have erected one of their patent high-pressure, non-condensing, twin-compound engines, which drives two dynamos, one a Victoria F 3, supplying 16 arc lights in use under the fountains, and the other a 20-light Brush machine supplying current to the 18 arc lights on the two 80 feet high masts and on the mast above the clock. Two engines of similar construction are placed in a building adjoining the Canadian Machinery Court each driving two Elwell-Parker 4-pole 50-unit horizontal dynamos. These provide the current for all the small glow lamps about the gardens and exterior of the buildings, about 11,000 in number, nearly all of which are of 5 C.P. We have been favoured by Messrs. Galloway with the following description of their engines.

The engines are of the Woolf type, that is to say, the cranks are placed opposite one another, or at an angle of 180°, so that the steam exhausts directly out of the high-pressure cylinder, 15 inches in diameter, into the low-pressure cylinder, 26 inches diameter, the stroke being 2 feet 6 inches. The engines are, consequently perfectly balanced both for reciprocating and rotary weights. The cranks are slotted out of the solid, and the shaft is $8\frac{1}{2}$ inches in diameter, in order that great stiffness may be secured. The bed plate is cast in one piece, and there are two overhung fly-wheels, one on each side, 10 feet in diameter and 16 inches wide on the face, so that the engine is perfectly symmetrical. The crank-shaft is probably the heaviest that has been used for an engine of the given dimensions, making 100 revolutions per minute with a steam pressure of 75 lbs. The crank shaft brasses are in four pieces, adjustable with wedges and screws. They were very carefully fitted in the plummer blocks, jammed tight and bored out in place at one operation, and then parted by a special tool. The slide valves are flat plates about $1\frac{1}{2}$ inch thick, six in number—that is to say, two admission valves for the high-pressure cylinder, two intermediate valves, which are at the same time exhaust valves for the high and admission valves for the low-pressure cylinder, and two exhaust valves for the low-pressure cylinder. The exhaust steam is conveyed under the floor to a cast iron box, 4 feet square, where



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it parts with much of its water, and thence passes up the brick chimney of the three Galloway boilers which supply steam. These, with a fourth or spare boiler, are the same boilers that were in use last year. The valves are driven by two excentrics. One of these is of cast iron for the low pressure slides; the other is of wrought iron turned out of the solid in the centre of the shaft, and it drives a rocking expansion link of the kind regularly used by Messrs. Galloway, and the high pressure admission slides. The expansion gear is not automatic. The grade of expansion can be regulated in a moment with the greatest nicety by hand, by means of the wheel seen at the back of the engine, which works a screw traversing the die in the expansion block. The governor is of Messrs. Galloway's well-known parabolic type. It is driven by grooved friction wheels and mitre gear, and operates a double-beat throttle valve in the vertical branch of the steam pipe. A coiled spring is so arranged round the weight shaft that its tension can be altered at pleasure, which has the same effect as increasing or diminishing the dead weight on the governor; and in this way the speed of the engine may be varied within wide limits without trouble, which is not always the case when the action of the expansion gear controlled by the governor is automatic. Thus, for example, it was intended to run the engines at 90 revolutions, but as rather more work was required from the dynamos than was anticipated, the engines have been speeded up to 100 revolutions.

The lubricating arrangements have been specially devised to overcome all difficulties. The crank-shaft has holes bored down each end, then along the outer crank web and then through the crank-pin; openings are made from this latter hole to the surface of the pin. The outer ends of the holes in the crank web are subsequently stopped by screws. Thus, passages exist from the ends of the crank-shaft to the crank-pins. A sight-feed lubricator is fitted to each end of the crank-shaft, and the centrifugal force is found much more than sufficient to draw in the oil and so lubricate the big ends in the most perfect manner. Sight-feed lubricators are fitted to every bearing, even to the cast iron excentric, which has a long groove or cell cut in the top of the hoop, into which the oil drops, no matter at what part of its throw it may be.

With reference to these engines, the following criticisms are passed by Messrs. J. & H. Gwynne in a letter published in last week's *Engineer*:—

"We take the present opportunity to say a few words about the governing of electric light engines. We quite appreciate the advantage of steady running for all kinds of work, but much nonsense has been spoken and written about defects in lighting due to imperfect governing in steam engines. We are at a loss to know what our electrical friends would have done a few years ago had the steam engine, and more particularly the unfortunate governor, not been at hand to answer for their sins of omission and commission, and to cover their inexperience. It is a fact that an engine driving a dynamo with a crowd of incandescent lamps properly fixed requires a governor just as much as one of our pumping engines when working under a constant head, that is, not at all till something goes wrong, or a big change takes place in the number of lamps on circuit. The dynamo governs the engine to perfection, just as the head governs the revolutions of the pump. Many marine engineers do not use the governors provided with our engines for ship lighting. With regard to arc lamps, one need only stand for a few minutes in a public place to see that the carbon-feeding mechanism wants a governor very badly, and that irregularities in lighting due to imperfections in lamps are greater by a hundred per cent. than could be caused by the worst-regulated engine ever put down to drive a dynamo.

"We cannot admit that mill engines give less trouble than good engines used in other branches of industry. The carefully-compiled analysis of breakdowns published by Mr. Michael Longridge, of the Engine and Boiler Insurance Company, every year, gives most instructive evidence on this point, as we presume that most of the engines which fail belong to mills in Lancashire and Yorkshire. Among mill owners, as among other steam users, there are some men far-seeing enough to look beyond the mere first cost of their machinery. Such men go to builders of high reputation and great experience, pay a good price, and secure engines which give them no trouble. The skill and experience necessary to produce good engines for electric lighting are not now lacking, and if buyers will allow for a margin of power beyond their probable or calculated requirements, prepare themselves to pay a good price, then go to an engineer who has a reputation to lose, not to an engine maker, and leave all details in his hands, they will be provided with engines which will run as well as the best mill engines ever produced.

"Outside of defects in the electrical department, the causes of engine failures have been obvious enough. The chief of these is over-driving; cheap and badly-designed engines put down too small, and driven at a pace which kills them; well-designed and well-made engines put down too small, because the power is under-estimated, and driven at speeds which scientific investigation shows to be injudiciously high for smooth and permanent working. It must not be inferred from the foregoing statements that there is any difficulty in making an engine run at very high speed with perfect safety; we merely mean that there is a speed for every engine, beyond which it may not be driven with impunity. We have engines with 10 inch cylinders running beautifully all day long, fully loaded, at 450 revolutions per minute, simply because they are specially designed to run properly up to this speed. Were we to put another 150 revolutions to the speed, all the conditions would be altered, and very likely trouble would arise sooner or later.

"We are glad to be able to acknowledge that during the past two years electricians have shown great readiness to reduce the speeds of dynamos, so that direct driving can be satisfactorily resorted to in the multitude of cases in which installations such as Messrs. Galloway's would be quite inadmissible, owing to want of space."

The fountains of the Indian and Colonial Exhibition are illuminated from underneath by nine large hand-fed arc lamps, specially designed and made by the Woodhouse and Rawson Electric Manufacturing Company, Limited. The carbon holders are mounted on insulating blocks attached to saddles, which slide on two brass tubes fixed to end brackets, the whole being supported at about 20° angle with the horizontal base plate. The feed is effected by a screw passing through the saddles between the tubular guides, one end of which has a right hand thread, and the other a left hand thread of double the pitch. This screw is carried through one end bracket in a tapped bush which is partly split, and can be clamped on the screw by a nut running on an outside taper thread. When this is so clamped, the turning of the screw hand-wheel simply gives the necessary feeding motion, one carbon moving at twice the rate of the other; but if the tapped bush is unclamped, and turned on the screw by a hand-wheel attached to it, the screw and carbon holders are shifted bodily longitudinally, thus giving a horizontal adjustment of the position of the arc. To give a universal adjustment of the position of the carbon points with regard to each other, one of the carbon holders consists of a bracket carrying a cylinder fixed horizontally and at right angles to the screw; on this cylinder is a sleeve carrying the carbon holder proper, which can be moved horizontally or turned on it in a vertical plane, thus giving a perfect adjustment of the points; this sleeve is moved and clamped in position by an insulated handle which acts as a set screw.

Messrs. John White and Sons, of the Park Road Leather Works, Bingley, Yorkshire, who supplied the leather belting for driving the machinery in the electric light department of the International Inventions Exhibition of 1885, have been retained in the same department for the Colonial and Indian Exhibition of this year. The following particulars relating to a portion of the main

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belts of 1885 may be of interest, showing such combined results in belt driving as have probably never been previously attained :—

	Length.	Width.	Speed.	Transmitted.
No. 1	—70 ft.	× 10 in.	... 2,585 ft. per min.	... 120 I.H.P.
„ 2	—73 „	× 15 „	... „ „ „	... 170 „
„ 3	—60 „	× 16 „	... 3,270 „ „	... 200 „
„ 4	—86 „	× 24 „	... 2,585 „ „	... 350 „
„ 5	—„ „	× 15 „	... „ „ „	... 170 „
„ 6	—„ „	× „ „	... „ „ „	... 170 „
			Total ...	1,180 „

THE ROYAL HOLLOWAY COLLEGE.

ON Saturday last, at the invitation of Mr. G. Martin-Holloway, a large company of gentlemen inspected the splendid pile which has been built at Mount Lee, Egham, for the purpose of a ladies' college, and which owes its existence to the philanthropy of the late Mr. Thomas Holloway, who during his lifetime provided and dedicated the necessary funds for its erection and endowment. In every respect the liberal intentions of the founder have been carried out by the trustees in a thorough and even lavish manner, with the result that the site, the buildings, and the fitting up and furnishing are everything that could be desired. The work is now aptly brought to a conclusion by recognition on the part of the highest lady in the land which, it is said, has never before been accorded to any similar institution. The privilege of using the prefix "Royal" has been granted in other cases, but only after the ceremony of opening has been performed by a member of the royal family; but in this instance Her Majesty has already voluntarily commanded that the institution shall be henceforth called the Royal Holloway College, and has also expressed her willingness to perform the public opening ceremonial on the 30th. The electric lighting of the college buildings was entrusted only a very few weeks ago to Messrs. B. Verity and Sons, of King Street, Covent Garden, who in the short space of time allowed them have produced some specimens of artistic brasswork of a most elaborate character from special designs, some of which were supplied by the architect, Mr. Crossland. Through the library and museum there are 16 massive Renaissance brass standards raised on marble blocks, each supporting six branches terminating with glass shades, covering 32 C.P. lamps. The recreation hall, which contains a choice selection of paintings brought together by Mr. Martin-Holloway at an outlay of over £80,000, is beautifully lighted by electroliers. In the dining hall a different plan is adopted, the lamps being in twelve groups close to the ceiling, each group of six lamps being under a green reflector. Some brackets of exquisite design add to the splendour of the chapel, the roof of which is decorated with coloured figure subjects in high relief, the principal one being, very aptly, the creation of Eve. At present only the ground floor is fitted up for lighting, the total number of lamps being 600, but it is expected that ultimately it will be extended to the whole building, when the installation will form one of the largest in existence. The lamps are all Edison-Swan of 16 and 32 C.P., and the two dynamos are Edison-Hopkinson 400-ampère machines. These are driven by a Davey, Paxman and Company's horizontal compound engine. The system of small circuits is adopted, none exceeding 25 ampères, and the switches and cut-outs are all double-pole and made substantially on slate. For the machinery a special building has been put up of a most substantial character, and with every convenience, nearly a quarter of a mile from the college buildings, nearer Egham. At the same spot all the household supplies and stores will be received, and for the despatch of these to the main building a tunnel has been made and rails laid. The trucks on this miniature railway will no doubt be worked by an electric motor, though we are not aware that this is actually decided upon.

THE UPWARD PRIMARY BATTERY.

WE give this week a more detailed account of the Upward battery, as promised in our last issue.

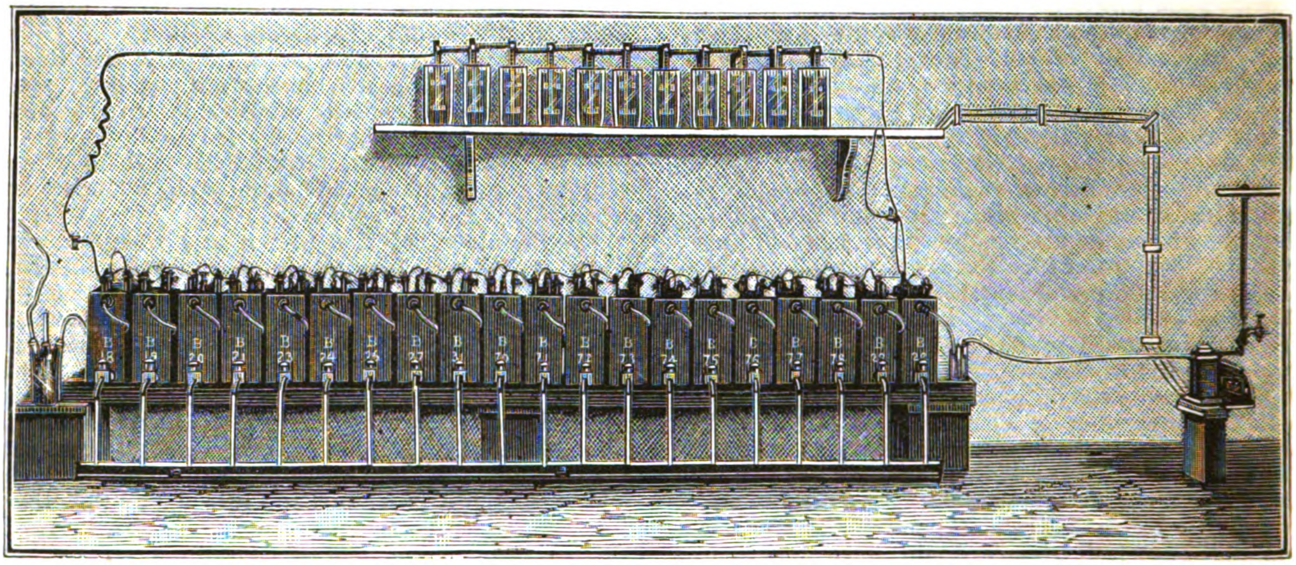

FIG. 1.

Fig. 1 is engraved from a photo. of a battery of 20 cells, which has been at work for the last six months in the works of the Woodhouse and Rawson Electric Manufacturing Company, and which requires absolutely no attention whatever, except the weekly addition of water to the zinc cells to make up for what has percolated through the porous pots into the outer cells. The zinc plates were all replaced about a month ago. They had by constant use been reduced to the thinness of a wafer, and the renewal only occupied one man between 30 and 40 minutes.

This illustration and figs. 2 and 3, which are a section and side elevation of a single cell, will make our last week's description quite clear; A is the outside glazed earthenware cell; B, the porous pot, C, C, the two carbon plates, surrounded by crushed gas retort carbon, and sealed with cement at H; Z, the zinc plate; D, the gas inlet to outer cell; E, the gas outlet; T, earthenware tap, connected to a glass tube, F, which dips in the trough, G. The trough is constantly full of zinc chloride, which has drained out of the carbon cells. The dimensions of these particular cells are $11\frac{1}{2}$ inches × $5\frac{1}{2}$ inches and $12\frac{1}{2}$ inches deep.

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The zinc chloride solution which is formed by the working of the battery, very slowly percolates through the porous pot, B, into the outer cell, and insures the broken carbon remaining moist; but the tap, T, which is always open, prevents any liquid accumulating in

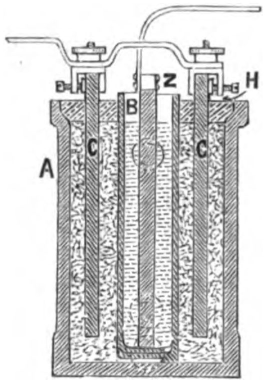

FIG. 2.

the outer cell; allowing it to run down F into the trough below. The level of the liquid in this is always kept above the orifice of the tubes, so that no gas escapes, while an overflow is provided into the house drain. ($Zn\ Cl_2$ is an excellent disinfectant.) The method of supplying the cells with chlorine gas is highly ingenious. The gas arrives from the holders

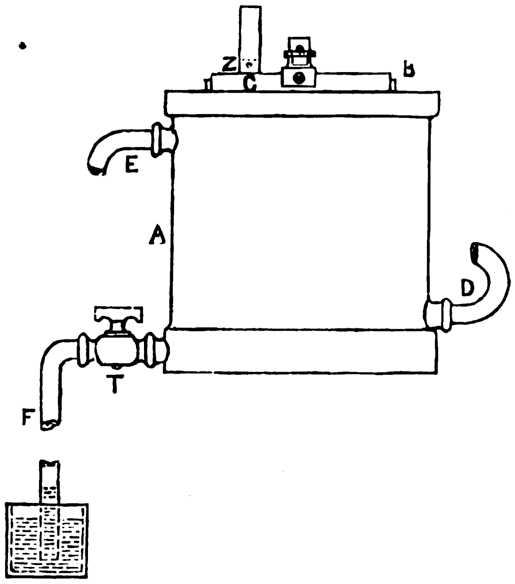

FIG. 3.

(of which more hereafter), by the tube seen at the left of fig. 1, where it passes into a bubbling bottle, from which it enters the lower part of the first cell (B 18); the exit at the upper part of this cell is connected by a tube to the inlet at the lower part of the second cell, and so on through all the cells in series; the exit of the last cell being connected by a tube, through another bubbling bottle, to a simple water aspirator or ejector, shown at O, fig. 4.

Assuming the cells to be all full of gas and the circuit closed, the gas will be equally consumed in every cell in proportion to the current; and, as the carbon cells are hermetically sealed, a vacuum is gradually produced, thus drawing further supplies of gas from the holder. If the chlorine were absolutely pure no further feeding would ever be required as the cells would always keep themselves supplied from the holder.

In practice, however, it is not possible to prevent the admixture of a small quantity of air (say 3 per cent.), and a consideration of the conditions will show that this air must first accumulate in the last cell.

The E.M.F. of this last or right-hand cell will, therefore, drop before that of the others is in the slightest degree affected; and this drop is arranged to automatically open the aspirator by means of the apparatus shown in figs. 4, 5 and 6, and to cause the removal of this accumulated air.

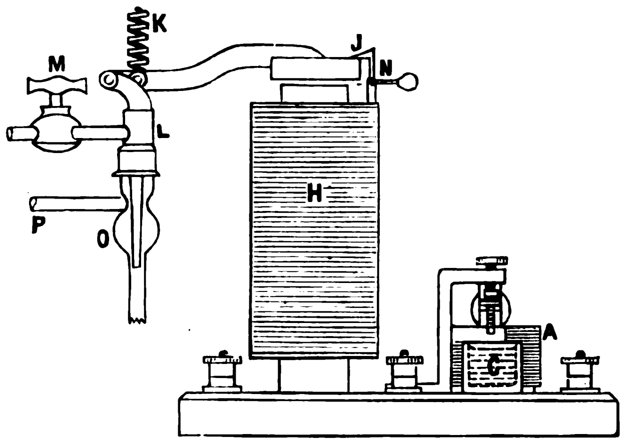

FIG. 4.

The terminals of the last cell are joined to the terminals of a high resistance magnet, A, which, when the E.M.F. of this cell is normal, has sufficient power to pull down its polarised armature, D, and the course of the main current from the battery is from the last

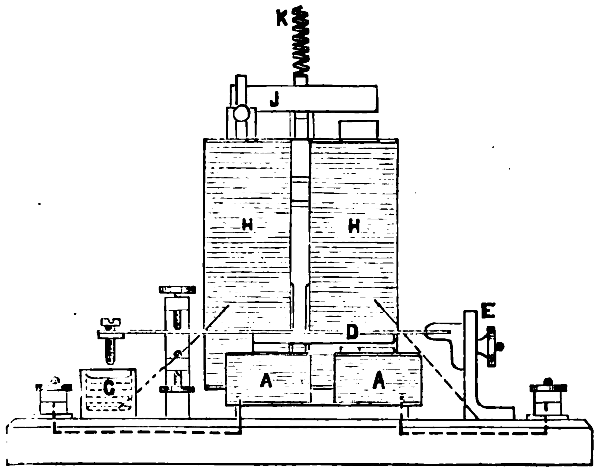

FIG. 5.

cell through the mercury cup, C, armature, D, and pillar, E, to the outer circuit; but when the E.M.F. of this last and master cell falls by reason of accumulated air, the armature is released, and contact broken at C, so that the main current has to pass round the large

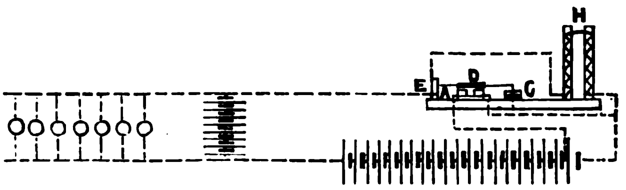

FIG. 6.—DIAGRAM.

electro-magnet, H, to the outer circuit. The armature, J, of this magnet is then attracted, and opens the adapted "ball valve," L, which is normally kept closed by the spring, K; water then enters the aspirator, O, drawing off the air from the last cell, through the tube, P. As soon as the air is replaced by chlorine the E.M.F. of the cell rises again, the armature, D, is

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attracted, the large magnet short-circuited, and the armature, J, released, so that the water supply and action of the aspirator is stopped.

When the battery is in regular use the aspirator "goes on" for about 30 seconds, at intervals of from one to three hours, according to the purity of the gas. The quantity of water used is therefore infinitesimal, and there is absolutely no waste either of water or gas.

The form of gas holder which has been adopted after much experiment with mechanical and liquid sealed holders is shown in fig. 7. It consists of several columns made of ordinary earthenware drain pipes cemented together and tarred on the outside.

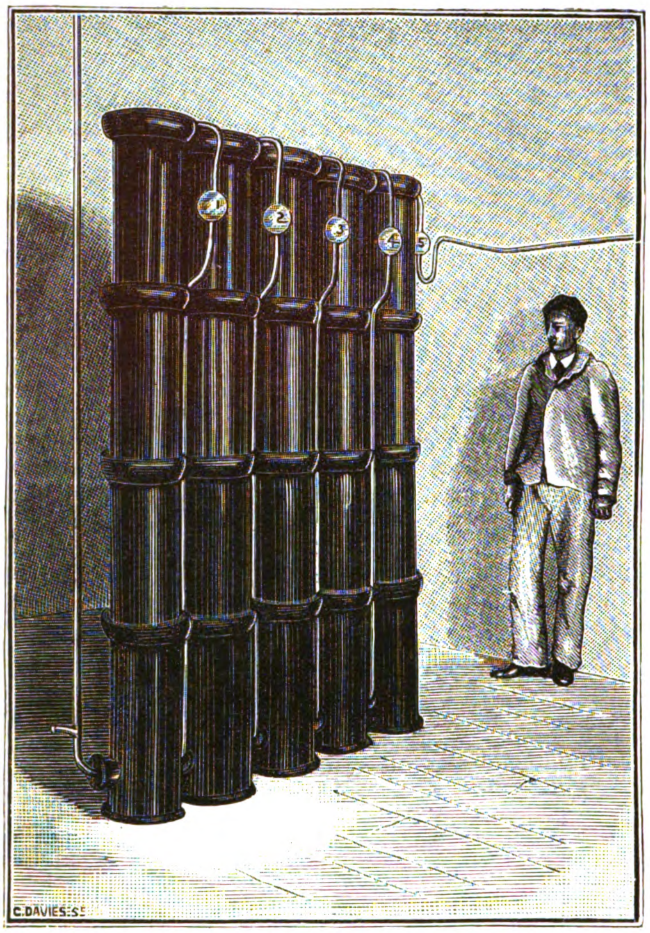

FIG. 7

The chlorine gas from the generator, which is two and a half times as heavy as air, enters the first column by a tube at the lower end, displaces the air and overflows through a lead tube to the bottom of the second column which also becomes filled from the bottom upwards; the third and succeeding columns then fill in the same way, the number employed depending on the amount of gas it is desired to store, each column of four 9-inch diameter drain pipes holding gas equivalent to about 460 watt-hours. Each of the lead tubes connecting the columns is provided with a glass bulb painted white at the back, which enables one to see at once how many columns are filled with gas, as the well-defined colour of the chlorine shows up distinctly against the white back ground. The last column is provided at its top end with an outlet tube carried into the outer air.

Up to the present time the manufacture of chlorine gas has been distinctly an operation to be carried on out of doors, and Mr. Upward fully recognised that unless the gas could be easily produced in a perfectly inodorous manner its use for household purposes would be impracticable.

The method adopted is remarkably free from any objection on this score, the whole operation being perfectly free from smell and extremely simple, so that any servant can do all that is required. The generator consists of a round outer earthenware pan, 18 in. diam. by 12 in. deep, permanently set in a sand bath, which is heated by a small gas jet or small oil flame; the quantity used of such fuel being extremely small. In this outer jar is placed a perforated earthenware vessel, containing a month's charge of manganese, the whole being closed by a cover with a water seal, which makes the generator absolutely gas-tight. In the cover is a funnel, provided with a tap, and when it is required to make gas, the funnel is filled from a vessel containing concentrated brine and from another containing dilute sulphuric acid, and the tap being turned, the contents pass into the generator.

The chlorine generated is led away through a hole in the cover to a bubbling bottle and then to the holder, a branch tube being taken off to the batteries. At the bottom of the outer pan is a tap and pipe to the drain, for emptying the liquid when spent. When the charge of manganese has become exhausted by constant repetition of the above process, the pan is filled, through the funnel, with water, so as to wash it and expel the least trace of gas. The water is then run off, the cover lifted, and the perforated vessel re-filled with fresh peroxide of manganese. The replacing of the cover then renders the apparatus fit for further generation of gas. The small size cells shown in the reproduced photo., fig. 1, have each an internal resistance of ·2$^{\omega}$. They can, of course, be made of any desired internal resistance, and there is a large one at the works which gives 150 ampères on short circuit.

It is intended that the battery shall generally be used in conjunction with accumulators, so that advantage can be taken of the power the battery has of continuous working, allowing a much larger number of lamps to be run by charging the accumulators continuously day and night; while the E.M.F. at the terminals of the lamps is maintained constant with varying currents. A set of 11 accumulator cells is shown above the Upward Battery in fig. 1.

Some of the details of manufacture will show what great pains have been taken to make the battery a perfectly permanent thing and fit for use in unskilled hands.

The whole of the outer cell being covered in with cement, the carbons are a fixture, and never require the least attention; the terminals on the carbons are brass clamps, and they have been found never to corrode or give the least trouble, there being no creeping of the liquid. The zinc connection is a copper strip rivetted on to a lug cast on the top of the zinc plate, and the porous pot is thoroughly soaked in cement for an inch from the top, so that this part never gets damp or affects the cement seal. The tubes from cell to cell are perfectly insulated from the carbon inside; lead is used for the tubes, and is found to be practically unaffected by the gas, a thin coating of lead chloride forming on the inside which completely protects it. The gas is *drawn* into the cells, not *forced* in, so that there is a slight vacuum (2 or 3 inches of water) inside which effectually prevents any possibility of leakage of chlorine, which might occur if there were pressure inside. The liquid used—$Zn\,Cl_2$—(the supply of which is kept up by the action of the cells) is deliquescent, so that there is no tendency of the crushed carbon to get dry.

The description and fig. will show that apparently the utmost simplicity has been attained, and that there is nothing in the battery at all likely to get out of order.

Its E.M.F. is 2·1 volts, and is absolutely constant so long as chlorine is supplied. The whole of the chemical changes being the combustion of zinc or iron by chlorine, and that purely electrolytically, there is an entire absence of local action. This has also been proved by delicate tests, and is clearly shown by the condition of the zinc plates shown us which came out of the cells all on the same day, all used up to the thinness of a wafer, and every one to the same extent.

To the probable user of a primary battery information on the amount of attendance required and the possibility of inconvenience is of the greatest interest.

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Assuming the battery and apparatus to be installed in a cellar, outhouse, yard, or other convenient position, all that a servant has to do is once a month to fill the generator with a charge of maganese, and every few days to run sulphuric acid from one tap and brine from another into the funnel, after opening the lower tap to allow the spent liquid to run off into the drain, at the same time the burner underneath may be lighted, or if preferred the heat may be arranged so that the process is continuous. The necessity for fresh or more rapid generation of gas is indicated by the colour-bulbs in the tubes between the holders, which show how many columns full of gas there are in hand.

The only other attention necessary is to fill up the cells with plain water once a week.

By using heavy zinc plates the renewal of these is only necessary once in six months or more, and, as before stated, they are all consumed alike, so that the whole are ready to be replaced on the same day.

If a battery is going to be unemployed for a considerable time all that is necessary is to turn off the taps, T, and raise the safety tube of the first bubbling bottle. The cells then draw in air instead of gas and soon stop, leaving any gas in the holders for future use, while the liquid only percolates through the pots till it is level outside and in. To start the battery again it is only necessary to open the taps, T, push the safety tube down again, and fill up with water, as plenty of zinc chloride solution has been retained in the inner cells.

With regard to the cost of the electrical energy produced by the battery, it is not to be considered that this will be so low as when obtained from an engine and dynamo; but in many cases these are perfectly inadmissible, and it is here that a reliable primary battery becomes invaluable. As to the actual working cost, for 1,000 watt-hours work done we shall require, according to the inventor's calculations, $\frac{1{,}000}{2 \cdot 1}$ ampère-hours; or, since 1 lb. zinc is equivalent to 374 A.H., $\frac{1{,}000}{2 \cdot 1 \times 374} = 1 \cdot 27$ lbs. at $2\frac{1}{2}$d. per lb. $= 3 \cdot 2$ pence, and 1·27 lbs. of zinc to form $Zn\,Cl_2$, consume $1 \cdot 27 \times \frac{35 \times 2}{65} = 1 \cdot 36$ lbs. Cl. We have no exact data of the cost of chlorine, but we believe it is generally reckoned, where used on a manufacturing scale, as costing £5 per ton. Of course, we cannot expect to get it at that rate on a small scale; but even assuming it cost six times as much, or $3\frac{1}{4}$d. per lb., we have the total cost per 1,000 W.H. as under 8d. Allowing for the battery working at a very high rate, and for loss in the accumulators, let us assume that as little as one half of the total work is done on the lamps, then taking lamps of the efficiency of 3 watts per candle, we have an outside cost per 1,000 C.P. hours of 8d. × 2 × 3, or 4s., or $\frac{1}{2}$d. per hour per 10 C.P. lamp. Now, when burnt in an ordinary burner, 5 feet of gas do not give *more* than 10 C.P., so that, even taking the extreme figures for cost that we have done, we have electric light at a cost equivalent to gas at 8s. per 1,000 cubic feet.

We have no hesitation in saying that if the battery gives as little trouble as asserted, there should be a very large field for its immediate introduction; and from the cells we saw and the report of Prof. Oliver Lodge, which, we learn, is particularly favourable, we have great hopes of its commercial success, believing it to be the first thoroughly practical primary battery for electric lighting.

Telegrams to the West Coast of Africa. — The secretary of the West African Telegraph Company states that the company has now opened its Bathurst station, to which messages may be sent *viâ* Cadiz, from the offices of the Direct Spanish, Eastern, and Submarine Telegraph Companies, and from any postal telegraph station, the tariff being 5s. 11d. per word.

A DECISION IN FAVOUR OF THE BELL COMPANY.

UPON an application for a preliminary injunction in the case of the American Bell Telephone Company *et al. v.* National Improved Telephone Company *et al.*, tried in the Circuit Court of the United States for the Eastern district of Louisiana, the following was delivered as the opinion of the court:—

This cause is before us on an application for a preliminary injunction, upon bill, answers, numerous affidavits, depositions and exhibits. We heard the application discussed by the solicitors on both sides, with many adjuncts of experiment and illustration, for the period of twenty-one days, and we have striven to give to the question the study and consideration to which it is entitled, from the fact that so many of our fellow-citizens throughout the entire country are interested in its decision.

A very long discussion, in which solicitors of ability and learning participated—such as has been the one conducted before us—has one great advantage: it tends to separate, by a clear line of demarcation, that which is sound in law and sustained in fact, from that which, however plausible and forcibly urged, analysis and proof compel the abandonment of.

The complainants have urged that since the patents involved here have been the subject of judicial investigation, ending in decisions in the Circuit Courts of the United States maintaining their validity, that so far as the issues presented in those causes have been identical with those involved in this cause, for the purposes of granting a preliminary injunction to run *pendente lite*, those prior decisions elsewhere obtained are sufficient. We assent to this doctrine.

The proofs submitted to us include degrees affirming these patents by Mr. Justice Gray, Mr. Justice Matthews, Judge Lowell, Judge Blatchford, Judge Wallace, Judge Nixon, Judge McKennan, Judge Butler, Judge Acheson; with opinions at more or less length by Mr. Justice Gray, Judge Lowell, and Judge Wallace. It has been urged by the respondents, that in all these causes save one, there was either an absence of one or more of the defences here urged, or collusion between the parties and consequent imposition upon the courts; so that the degrees and decisions submitted and referred to above should not of themselves be the basis of the decision and decree here. In the Molecular case, decided by Judge Wallace last June, there has been no charge of collusion and consequent imposition. We think that these causes abundantly show that the substantial defences here submitted have been urged in several of those cases (though perhaps they have not been urged with the vigour and persistence that have characterised the defence here), and that the settled practice in the Circuit Courts of the United States would authorise the granting of the injunction *pendente lite*, upon the authority of the decrees in those cases.

We do not understand that the weight given by one Circuit Court to the adjudications of another, rests entirely upon the basis of comity; but as well upon that of recognised rights and of convenience, and that it is largely to prevent the necessity of more than one court going through with the investigation of the same facts, that the inference derived by the first court is for the purpose of determining whether or not an injunction shall go, till the final decree adopted by the other Circuit Courts. In addition to the weight to be given to the adjudications in favour of the Bell Company in other circuits, on the basis of convenience, comity, and recognised rights, it is urged that the National Improved Telephone Company, the principal defendant here, is estopped by the final decree rendered by Judge McKennan in the Pittsburg case, because it was privy to that suit, and had a day in court there.

The evidence shows that the National Improved Telephone Company, claiming to own certain patents pertaining to telephony, was the licensor of the Pittsburg Company, and contracted, for a consideration received, that in case of any litigation involving the validity of said Letters Patent, or any of them, wherein the Pittsburg Company should be a defendant, the said National Improved Telephone Company should have prompt notice thereof, and should assume control of said litigation, and at its option be made a party thereto at its own expense; that the Pittsburg suit did involve the validity of said Letters Patent; that the National Improved Telephone Company was promptly notified thereof, and did assume control of the litigation; preparing an elaborate defence and appearing therein by counsel, who were heard by the court, and that becoming dissatisfied by the refusal of the court to go behind the decrees of other circuits in the matter of a preliminary injunction, the National Improved Telephone Company "ordered the immediate withdrawal from the court of all the evidence, instruments, and documents of every character connected with the defence," and "immediately dismissed the counsel in said case."

Counsel have argued that the National Improved Telephone Company had a right to withdraw from the litigation, and that thereupon, in some unaccountable way, the company was released from all responsibility, and that complainant had no right to proceed to a decree.

We cannot avoid the conclusion that so far as the National Improved Telephone Company is concerned in this suit, it is bound and concluded by the final decree rendered at Pittsburg, and that that decree alone warrants the injunction *pendente lite* in this case, as against said telephone company and its privies.

But since we have had the cause so exhaustively presented, and we have so fully considered it, we have determined not to

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rest our conclusions upon the decrees in the other circuits, sufficient as we deem those to be, but to examine the questions *de novo*.

It is urged by the defence that there should be given a weight to the fact that the executive department of the government has directed the institution of a suit to annul this patent, that should lead us to refuse or defer any affirmation of the patentee's rights till the conclusion of that suit. To this we cannot assent. The executive department has not in this case attempted to adjudicate rights, nor could it in any case do more than start the judicial inquiry, and present the cause to the courts. The filing of an information cannot create a presumption of guilt. No more can the institution of a suit to annul, create a presumption of nullity. If any effect is to be given to the pendency of this suit to annul, so as to suspend any rights of the patentee, it could only result from restraining or other orders issued in that suit, where the court, having the parties and the evidence upon which the nullity is sought to be established, before it, has also the authority, if to annul, then to suspend the force of the patent.

It is necessary to consider two grounds of the invalidity of the Letters Patent of Alexander Graham Bell, No. 174,465, issued March 7th, 1876, on application filed February 14th, 1876.

First, it is urged that after the filing of Bell's application, his specifications and claim were changed in consequence of information, derived through the Examiner of the Patent Office, from the caveat of Elisha Gray, filed on the same day with Bell's application.

We have reached the conclusion that the invention is set forth in the claim and specifications as originally filed, and that, therefore, any inquiry into this question would lead to nothing which could affect the validity of the patent.

It is overwhelmingly established that Bell made the affidavit to his claim and specifications as originally filed, on the 20th day of January; and that Gray's description of his invention embodied in his caveat, was not written out till three or four days prior to February 14th, when it was filed.

The fifth claim of Bell originally filed, is as follows:—

"5. The method of, and apparatus for, transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

In the specifications originally filed by Bell there is a figure and description and illustration of the apparatus and process.

Another mode is shown in fig. 7, whereby motion can be imparted to the armature by the human voice, or by means of a musical instrument.

"The armature, *c*, fig. 7, is fastened loosely by one extremity to the uncovered leg, *d*, of the electro-magnet, *b*, and its other extremity is attached to the centre of a stretched membrane, *a*. A cone, A, is used to converge sound vibrations upon the membrane. When a sound is uttered in the cone the membrane, *a*, is set in vibration, the armature, *c*, is forced to partake of the motion, and thus electrical undulations are created upon the circuit, E, *b*, *c*, *f*, *g*. These undulations are similar in form to the air vibrations caused by the sound; that is, they are represented graphically by similar curves. The undulatory current passing through the electro-magnet, *f*, influences its armature, *h*, to copy the motion of the armature, *c*. A similar sound to that uttered into A is then heard to proceed from L."

To simplify: In the 5th claim and the part of the specification quoted above, the applicant declares that his invention consists in this: In the discovery that vocal or other sounds, by being uttered or otherwise communicated through a receiver, and by reason of their force being made to impinge upon an armature, impart to it the vibrations of the air; that these motions of the armature cause corresponding undulations in the electrical current, so that, at the end of the circuit, similar vibrations are given to another armature, through it to the surrounding air, and through the air to the human ear. Thus voice is communicated to the electrical current, and reproduced at the end of the wire in the air, and all this by reason of the discovered fact that vibrations in the air caused by sound, are so similar to the undulations in the electrical current, that vocal sound, of whatever character itself, may be passed from air to the electrical current, and delivered again through the air by means of a receiving and a delivering, or emitting armature.

The great discovered fact was that the vibrations in the air are similar in form to the following and imparted electrical undulations, and that the undulations are similar to the ultimate vibrations.

It follows that as are the vibrations so are the undulations, whether gradual or sudden, of whatever pitch or loudness, whether constant or varying in pitch or loudness, whether caused by a single or by successive sounds. We think this a sufficient description of the process and apparatus and of the whole discovery patented, and that it neither required nor did it receive any substantial changes by the amendments subsequently made, no matter from what source suggested or derived.

Another objection urged by the defence was that the apparatus described in the specifications and illustrated by fig. 7 is not capable of transmitting articulate speech. There are affidavits to this effect, but the affidavits in favour of the capability are very strong and satisfactory, and the court itself, through its own senses, was convinced that the transmission of speech had been completely attained by means of the Bell apparatus, as exhibited by figure No. 7.

The fact that Bell's invention certainly dates from January 20th, 1876, and that it covers a speaking telephone, transmitting articulate speech by means of an undulatory, oscillatory or vibratory current of electricity, renders it unnecessary to pass upon the evidence relating to the tergiversations and claims of Gray; the alleged frauds of Bell in advancing his application for a patent; the illegal conduct and conflicting statements of Examiner Wilbur; and many alleged vices and irregularities, the evidence of which forms the bulk of the record, and apparently the main defence in the case.

At the same time, it is proper to say that in all the evidence we have found nothing that shows that Bell has done or caused to be done anything inconsistent with his right to be called an honest man, with clean hands.

If he availed himself of information derived from Wilbur as to the contents of Gray's caveat, filed on the same day as his (Bell's) application [which, however, does not appear], he had a right to do so to enable him to restrict and limit and clearly define his application; as the information shown to have been furnished, was furnished under the authority of rule 33 of the Patent Office for such purpose.

We will next consider the second ground of defence, which is that the invention of Bell lacked novelty, because it had been anticipated by Philipp Reis.

That Reis made great strides towards the discovery of the great fact or law, subsequently announced in the fifth claim of Bell, does not admit of doubt.

That he failed to reach it is equally beyond question.

Reis discovered that by means of the electrical current, sound could be received, transmitted and delivered. But it was the pitch of tones that was transmitted, and exclusively by means of an intermittent make-and-break current—a current incapable of conveying the form of sounds, protracted or varying sounds, and therefore incapacitated to convey articulate speech. His apparatus appears to have been devised in the attempt to transmit speech by electricity; but the attempt was an acknowledged failure. His apparatus under the influence of the voice or other sounds, simply broke the circuit at each principal vibration with a frequency corresponding to the pitch of the sounds.

Prof. Trowbridge says:—

"It is impossible to transmit speech electrically by means of that operation; for the reproduction of articulation requires the reproduction not merely of the *number* of sonorous vibrations, but what is technically known as their *form* or character. The electrical changes on the line wire which are to convey this characteristic from the transmitter to the receiver cannot do that unless they take note of that characteristic and bear its impress. This is as certain as any elementary proposition of geometry."

Reis apparently had no idea of operating through a continuous, uninterrupted current, which should be undulatory, *i.e.*, should be plastic, impressible, and should be the medium of receiving freely and continuously, and reproducing exactly the vibrations in the air accompanying sound, by the corresponding disturbances in the electrical current, without any intermission of the flowing of the current.

In the Jahresbericht, or the annual report of the Physical Society of Frankfort for the year 1860-61, is an account given by Reis himself of his invention and apparatus. It was presented to the court as translated in the biographical sketch of Philipp Reis by Sylvanus P. Thompson, published in London in 1883. Upon a suggestion that the translation might be imperfect, we ordered that the memoir should be obtained from the Congressional Library, and should be translated into English by J. Hanno Deiler, Professor of German in the Tulane University. We have carefully compared M. Reis's description of his invention and apparatus as given in the two translations. While differing in the words used in the two renderings, they agree in making Reis state that he uses an "intermittent current," and that "each sound wave effects an opening and closing of the current." This is made even more palpable by his illustration of his apparatus or instrument.

This is entirely inconsistent with any idea of a continuing current which should undulate, *i.e.*, be increased or diminished merely, by an apparatus so constructed as to be susceptible of being set in motion by the vibrations of the air produced by sound, and should freely receive, convey and deliver single or successive sounds, by reason of being so constructed as to be capable of being started and continued in motion just so long as the vibrations of the air lasted. He did not apply to his instrument the law—indeed, he seems not to have designed his instrument with any reference to the law—that the vibrations in one medium had an exact correspondence to the undulations in the other, not only for an instant, but for any period of time.

The merit, and, as we think, the originality of the Bell invention consisted in the discovery of this law, and in the construction of his apparatus so that when the sound caused aerial movements or vibrations, they might, without any intermission of the current, be freely transferred or translated into electrical undulations, which again, at the end of the circuit, would freely reproduce the aerial vibrations, and thus convey, single or combined, transmitted sounds to the ear, and continue to convey them without interruption, as originally uttered, whether single, combined or successive. Reis's result was that sound could be sent through the electric current like a missile through the air; Bell's result was that the electric current was a continuing connection between voice and ear, like the air itself.

A great fact in proof of the correctness of this deduction is

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that the instruments invented by Reis and his methods were described in many scientific papers and works, and were well known in the scientific world, and the instruments were manufactured and on sale in Paris, Vienna, and Frankfort, and had been exhibited before the British Association, and a pair were deposited in the Smithsonian Institution; and yet before 1876 there was no speaking telephone in use, nor any pretence of any.

The various reproductions of Reis and his methods, all were based upon the same defective electrical means—an intermittent circuit-breaking current—and all were practical failures for the transmission of speech, until Bell's method was discovered.

From the evidence submitted in this case it seems clear that now, in the present state of the art, neither the Reis instruments nor any reproduction of them can be made to transmit articulate speech, except by changes of some form in the instruments themselves, or by the employment of Bell's method.

We therefore, conclude, that neither Reis nor his successors anticipated the invention of Bell as set forth in the fifth claim of his application and patent, and as illustrated by fig. 7, described in his accompanying specification.

The Meucci defence that is brought forward in defendants' record on this motion, taking up 120 printed pages, was abandoned by counsel on the hearing, and no effort made to sustain it.

There remains, therefore, but the question of infringment.

This matter has not been squarely met by the defendants.

The complainants' bill alleges, and their experts testify in the opening papers, that the instrument used by the defendants consists of a microphone transmitter, and a magneto receiver which has been decided in the Spencer and Molecular cases to be an infringement.

The defendants in their answer (unsworn to), in a vague and argumentative way, deny infringement.

In their affidavits, they do not attempt to show what they were using at the filing of the bill; but they allege, in affidavits filed pending this motion, that "Defendants' apparatus, as now used, may be more particularly defined as operating in method or principle of operation under the Reis inventions of 1860-4, and under special inventions patented by Randall, May 21st, 1878, May 4th, 1880, and May 3rd, 1881." Complainants having filed affidavits showing infringements in this apparatus now used, leave was granted to defendants to file another affidavit stating fully what it is that defendants use. Under this leave an affidavit of C. A. Randall (the sixth in the record) has been filed, which contains much impertinent matter reflecting on counsel and opposing experts, but throws no direct light upon the question; but from the affiant's argument we infer that he means to say that defendants are using the apparatus above referred to. The complainants urge, and their affidavits show, that the instruments of the Randall patent, above referred to, transmit speech by means of the Bell variations of current, and we are disposed to agree with them in this view.

Let the injunction issue.

DON A. PARDEE, *Circuit Judge.*
EDWARD C. BILLINGS, *District Judge.*

Filed May 31st, 1886.

ELECTRIC LIGHTING ACT (1882) AMENDMENT (NO. 3) BILL.

House of Lords, Friday, June 18th.

ON the report of amendments to this Bill being brought up,

LORD HOUGHTON moved the following new clause to be inserted before clause 1:—

"Notwithstanding anything in the Electric Lighting Act (1882) no provisional order authorising the supply of electricity by any undertakers within the district of any local authority shall be granted by the Board of Trade except with the consent of such local authority, unless the Board of Trade in any case in which the consent of such local authority is refused are of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, and in such case they shall make a special report stating the grounds upon which they have dispensed with such consent."

VISCOUNT BURY pointed out that several Bills dealing with electric lighting had been referred to a Select Committee some time ago. The Committee heard a great deal of evidence not only from local authorities in various towns throughout the country, but from many other persons interested in electric lighting. The opinion at which the majority of the Committee arrived was that although it was fair that at the end of a certain number of years local authorities should be allowed to purchase electric lighting plant, yet that it would not be fair to give them undue preference. In consequence of that decision this clause, which formed part of an electric lighting Bill before the Committee, was, after discussion, deliberately rejected by a majority of the Committee. The noble lord now said that he had since received communications from the members of that Committee to the effect that they viewed with indifference the restoration of this clause in the Bill. This clause conferred on local authorities in various districts a power which had not even been granted to them by the obsolete Act of 1882. By that Act local authorities were given a power of prohibition of licences, but they had no power of prohibition in the Electric Lighting Act of 1882 for provisional orders. This clause, however, conferred on local authorities the power of voting provisional orders. After hearing all the evidence the Committee deliberately rejected the clause on the ground that it was giving local authorities undue power created now for the first time, and which did not exist in the Act of 1882. But now the noble lord came down in the last hours of a dying Parliament and tried to insert this clause rejected by the Committee. He submitted that such a proceeding was not fair. If anything was to be gained by such tactics he could imagine the noble lord making a fight for the clause; but there was really nothing to be gained by this attempt to reinstate the clause. The fact was that the noble lord wished to have something on record in favour of the local authorities, which had not yet been recorded by their lordships. He protested against the attempt and opposed the insertion of the clause.

The EARL of CAMPERDOWN said he wished to correct the noble viscount in two particulars. The first was that it was not quite correct to say that the Committee rejected the clause. The Committee divided evenly upon it; five voted in favour of the clause, and five against it, and by the rules of their lordships' House the decision was that the "Noes" had it.

VISCOUNT BURY: It was struck out on division.

The EARL of CAMPERDOWN said he wished to inform the House that in the Committee the numbers were even on the division, and that one member of the Committee was absent. He advised their lordships to accept the clause, because he could assure them that the Committee conducted its labours with the greatest possible care and considered both sides of the question in the most impartial manner. The clause did not actually alter the existing law in any sense which gave the local authorities any power; it simply recognised the existence of the local authorities, and said that their consent was to be given in the case of provisional orders, and that if they refused that consent in an unreasonable manner the Board of Trade should have the opportunity of overruling it. He supported the clause because it did not give any new power to the local authorities, and because it was a very reasonable one to insert in the Bill.

Their lordships divided, and the numbers were:—

For the clause	24
Against	37
Majority	—13

The clause was therefore rejected.

LORD HOUGHTON gave notice that he should not move the third reading of the Bill.

REVIEWS.

Electric Transmission of Energy. By GISBERT KAPP, A.M.I.C.E. London: Whittaker & Co.

(FIRST NOTICE.)

This is "a practical hand-book" *par excellence*—a book which will be read, studied, and used not by electricians merely, but by most engineers conversant with the English language. We would especially recommend this little treatise to those who are masters in matters appertaining to the mechanical transmission of power, for it is more than probable that electricity will soon take the most important place in the curriculum of experts in this particular subject. Until recently, problems on the transmission of energy to great distances could be solved by three means, principally, viz., by the hydraulic, the pneumatic, and the tele-dynamic means; each of these has its peculiarities, advantages, and disadvantages. Sometimes one of these systems was found more convenient or more economical than another, but neither of the three modes is universally applicable. Electricity may in many cases supersede water and air as regards economy, it will outweigh rope-gearing in points of convenience; but it is destined to find employment under peculiar circumstances where none of the other modes of transmission have hitherto been considered suitable.

Practical examples there are in sufficient number, and if the subject has not received the universal attention it deserves, the cause must be found in the want of a sober, systematic treatise. The literature on the electric transmission of energy has, up till recently, been rather unsatisfactory. Elaborate papers were read before scientific bodies, but they were mostly too elaborate to be of practical value. M. Marcel Deprez and others attempted to startle the world from time to time by announcements that energy amounting to several horse-power has been transmitted through several kilometres of telegraph wire; such facts, and the attendant mathematical reasoning, were very interesting in their way for the moment; but they did

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not serve to convey to the industrial man's mind, the full meaning which the experimenters attached to it.

Most of the attempts of transmitting energy electrically were by the general public regarded as experiments of a purely scientific nature, and of but small importance. The reports in periodicals concerning many examples were often couched in language unacceptable by the matter-of-fact engineer, and they were seldom sufficiently intelligible for the student. What we wanted was a systematic treatise, giving us a concise outline of the subject; a book which would lead us up step by step to a clearer conception of the whole business; a book which would teach us not only what has been done by others, and how they *did* the thing, but how we should do it ourselves. Mr. Kapp's hand-book gives us more than that; it goes a long way towards indicating ways and means of doing things better than they have been done before; and we venture to say that this book, small as it is, will have a most beneficial influence upon the immediate development of an important industry. We differ from Mr. Kapp on certain points, but we are bound to give him credit for excellency of style, systematic arrangement, and remarkable clearness of definition. The language of the author, to say the least, is lucid, and he displays a peculiar gift in the choice of happy illustrations; the first chapter, consisting of about 40 pages, contains the essence of modern ideas on lines of force, the relations between mechanical and electrical energy, and a capital explanation of the fundamental and practical units of measurements. The author's description of an "ideal motor" and an "ideal system of transmission" we thoroughly appreciate as giving the student in few words the characteristic outlines of a grand lesson; he will by a careful perusal of these pages get a clear notion of the elementary principles involved, and it will save him at once from drifting into that hopeless confusion which is so often produced in the brain of the student, young or old, by the reading of certain obsolete text-books.

The second chapter has some allusion to the historical development of electro-motors, but this only for the purpose of illustrating certain principles. Too much space seems to be devoted to the description of the original Siemens machine and the effects of the dead points in the "shuttle-wound" armature; no less than seven pages of descriptive matter accompanied by tables of tests with two Griscom motors are given to this discussion. The results of these experiments are of little value, in so far as this type of machine has never been of much use, unless as a toy, and we have sufficient evidence to believe that the author must be possessed of ample material of a more practical character. There is a passage on page 64 which we do not appreciate: it says, "If it be absolutely necessary to use a motor of that class, the field magnets of which are either permanent steel magnets or are electro-magnets excited independently, the waste can to a certain extent be prevented by inserting into the *armature current* an electro-magnet which will by its self-induction steady the current." The italics are our own; we assume that "armature current" is a misprint and should read *circuit*, but the whole explanation seems quite unnecessary, as no one would think of resorting to similar means in order to attain the ends indicated. If the author had carried out experiments (of a kindred nature to those mentioned on page 65 and tabulated at 66) with a couple of motors of a type and size wherein the *secondary* influences do not absorb 70 to 80 per cent. of the energy supplied at the terminals, then he would undoubtedly have modified certain general conclusions which were evidently based upon the results recorded. Supposing we run two rationally constructed motors in series with a given load, current, and speed, it does not follow that by joining the same motors in parallel and using half the E.M.F. we shall get the same current and speed. If the current were the same, then the speed should be greater than before, because the resistance of a pair in parallel must be one-fourth of that of the same pair in series; and we know that the influence of resistance upon the speed of series wound motors is very considerable.

We admire, however, Mr. Kapp's method of developing a practical theory of the dynamo or motor; his formulæ are intelligible, capable of being applied by anyone possessing an elementary knowledge of mathematics, and above all they are reliable; we have found them so, and we know of none better.

Electro-technical Photometry.—(*Die Elektro-technische Photometrie.*) By Dr. HUGO KRUSS. Vienna, Pest, Leipzig: A. Hartleben.

The present volume, which is comprised in the *Elektro-technische Bibliothek*, now being issued by the enterprising publishers, must be recognised as comprehensive and thorough-going.

Previous to the era of electric lighting, photometry seemed a very simple affair. So long as we had merely to compare the lights given out by lamps, candles, and gas burners the task was easy, since these various lights differ but little in colour and in intensity. But the introduction of the arc light gravely complicates the problem. Not only does the latter transcend the flames with which it has to be compared to an extent which at first sight appears almost limitless, but the difference of colour is a still more serious difficulty. If we cause one part of a white screen to be illuminated by an arc light and the other by a gas burner, the former portion appears of a greenish blue, and the latter of a red or orange. Now two such different sources of light appear to the eye completely incommensurable. It has long been observed that the yellow and red rays of light make a much stronger impression upon the human eye than the other colours of the spectrum. Hence even the Bunsen photometer, so valuable for comparing, *e.g.*, a gas flame with the standard candle or the Carcel lamp gives no trustworthy indications. To meet this difficulty a variety of expedients have been proposed, as we find here described. One of the most usual has been the interposition of coloured glasses between the source of light and the screen. Thus Tresca proposed glasses each of a colour complementary to the source of light. Concerning this method the author observes, very justly, that it is impossible to see how the loss of light occasioned on either hand by the intercalation of the glass plates is to be brought into calculation. Crova, on the other hand, suggests that both sources should be passed through a certain green glass, as devised by Sautter, Lemonnier & Co. But here we encounter the difficulty that as soon as the temperature of emission of an arc lamp differs from that of the one previously examined, the distribution of light in its spectrum is modified. Still this method may be regarded as applicable where the luminosities to be compared are approximately identical, *e.g.*, in testing lamps and machines of the same model working with the same number of rotations. The best expedient, however, for comparing sources of light of different colours, seems to be Wybauw's "compensation photometer," or a compensatory modification of Bunsen's instrument, devised by the author. For an account of the principles upon which these photometers are based we must refer to the work itself.

A special section of the treatise is devoted to a subject often overlooked by outsiders and amateurs, *i.e.*, measurements of sources of light at different angles of eradiation. It is the fact that arc lamps actuated by a continuous current radiate very unequally in different directions. The best arrangement, according to Dr. Krüss, is to leave both the comparison light and the photometer, and to introduce a mirror which renders the rays coming from the arc lamp, or other light in question, horizontal. An especial and needful caution is given at the close of this section concerning the necessity of preserving not merely the photometer screen, but the eye of the observer from all false lights.

The various normal and comparative sources of light are thoroughly discussed. The chief practical difficulty is the regulation of the height of the flame. It

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appears that during the lapse of four hours stearine candles burn with the normal height of flame only for 15 minutes, paraffin candles for 17 minutes, and spermaceti candles for 27 minutes. The mean fluctuations in luminosity are, with stearine 5·4 per cent., with paraffin 7·7, and with spermaceti 3·0 per cent. The last-mentioned material is, therefore, distinctly the most trustworthy. The author proposes to measure the height of the flame, not directly, but on its optical image as obtained in an instrument here described and figured.

In view of the manifest imperfections and irregularities of the standard candles, a variety of other normal sources of light have been brought forward, and are here discussed. Violle's unit, one square centimeter of platinum at its point of solidification, would have the preference if the practical difficulties connected with its application could be completely removed. At present it seems probable that the standard candles will be retained; but that they will be from time to to time gauged by means of the platinum unit.

In subsequent chapters the author discusses the brilliance of a light as distinct from its extent. He remarks that it is evidently not a matter of indifference whether a given quantity of light is radiated out from a small or a large surface. The brilliance (Glanz), G, is represented by the expression: $G = a \frac{J}{O}$, J being the quantity of light, O the surface of the light, and a a factor.

The measure of illumination is next considered as distinct from the luminosity of a source of light, a knowledge of which alone is evidently insufficient to give us a standard of the illumination actually produced.

Want of space, however, does not allow us to carry any further our examination of a work which must be strongly recommended not merely to electricians, but to all persons who have to concern themselves with photometry.

A very valuable feature is the copious index of works and memoirs bearing on the measurement of light, extending from 1729 down to the present year.

The Technics of Telephony (*Die Technik des Fernsprechwesens.*) By Dr. J. WIETLISBACH. Vienna, Pest, and Leipzig: A. Hartleben.

This work which forms the 31st volume of Hartleben's "Electro-Technical Library," takes a well-defined position. The author distinctly confines himself to a discussion of those apparatus and arrangements which have been found useful in practice. For the historical development of the telephone, the reader is referred to a former volume of the series. Nor are the applications of the telephone other than the transmission of verbal communications here taken into consideration. For information on the other applications of the telephone, such as in electro-dynamic measurements, in the examination of metals with the induction balance, in the detection of subterranean streams of water, and in physiological experimentation, other authorities must be consulted.

The author describes firstly the apparatus for the transmission of speech to a distance, including the telephone in the strictest sense of the word, the microphones of Hughes and Edison; signals, the battery, arrangements for protection from lighting, systems of apparatus and necessary appliances. A second chapter discusses the necessary conductors, ærial and underground, supports, wires, the humming of the wires, the effects of induction, &c. The humming and "singing" of telephone wires passing over the ridge of a house is certainly not a succession of accentuated sounds, like the ringing of church bells, the barking of dogs, a young lady "practising" in the next house. But now noise is clearly recognised as one of the factors of debility in our city populations, any addition to its sum-total is to be deprecated, and the attention which the author pays and directs to devices for deadening this humming sound is fully justified.

As regards telephony at long distances, Dr. Wietlisbach remarks that if messages are sent with strong microphones through long iron wires, as the line becomes longer one consonant after another fails and only the vowels are reproduced.

A line of 100 kilometres in length is probably the limit at which all the consonants are reproduced. On a well insulated line the vowels may penetrate to the distance of 500 kilometres, but not a word can be understood. Hence for longer distances copper conducting wires should be used. In his concluding remarks the author holds that the difficulties in the way of telephony at long distances are not technical but financial. The line, *e.g.*, from Chicago to New York in order to be remunerative would have to earn 5s. per minute of the entire 24 hours. Hence the price even for a short conversation is £2 10s. But the same intelligence can be communicated by telegraph for a tenth part of this sum with approximately equal speed.

The work is, throughout, well and profusely illustrated, and all the more important appliances are clearly described.

Traité Pratique d'Electricité Industrielle. Par E. CADIAT and L. DUBOST. Second Edition. Paris: Librarie Polytechnique Baudry et Cie, 15, Rue des St. Pierres.

This new edition, the original of which we reviewed in the No. of the REVIEW for November 1st, 1884, has practically been arranged on the same lines as the old. The authors have, however, suppressed all descriptions of apparatus and all accounts of experiments which have an historical value only. Many new facts, on the other hand, have been given, so as to bring the work, as far as possible, up to date.

Journal of the Society of Telegraph-Engineers and Electricians, No. 61. E. and F. N. Spon, 125, Strand.

This number contains the following papers, with discussions on the latter, read before the Society:—"Economy in Electrical Conductors," by Profs. Ayrton and Perry; "Uniform Distribution of Electric Power from a Uniform Conductor," by Profs. Ayrton and Perry; and, "Electric Lighting by Means of Low Resistance Glow Lamps," by A. Bernstein. The "Original communications" are:—"Delany's System of Synchronous Multiplex Telegraphy," by W. H. Preece, F.R.S.; "The Relation of Electric Lighting to Insurance," by C. J. H. Woodbury, Boston, Mass. The usual "Abstracts" complete the number.

The Elementary Principles of Electric Lighting. By A. A. CAMPBELL-SWINTON. London: Crosby, Lockwood & Co., 7, Stationers' Hall Court, Ludgate Hill.

The aim of the author has been to supply the requirements of those who are anxious to obtain an elementary knowledge of the primary principles of electric lighting, but who have neither the time nor the inclination to read the subject at the length at which it is treated in text books. The author's attempt is not, we think, a particularly happy one, though there are undoubtedly good points in the work. The many attempts which are made to impart information of the kind in a few pages are all more or less failures, in our opinion. Those who, as the author says, "have neither the time nor the inclination" to read up the subject properly, had better, we think, leave it alone. Mr. Swinton's work contains but 28 pages of matter divided as follows:—1. Closed Hydraulic Circuit; 2. Electric Circuit; 3. Galvanic Battery; 4. Electro-magnet; 5. Galvanometer; 6. Electric Arc; 7. Swan Incandescent Lamp; 8. Arrangement of Lamps in Series; 9. Arrangement of Lamps in Parallel Circuits; 10. Complete Electric Lighting System.

MR. J. B. DANCER.

SOME days ago there appeared in the Manchester papers a letter from Mr. J. B. Dancer, recalling to our notice the large share that gentleman took in the introduction of photography to Manchester

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and Liverpool. But photography is only one of the many arts and sciences indebted to him; and though it is neither possible nor necessary to give a detailed catalogue of those services, the list that follows cannot be without interest to the Manchester public, whose townsman Mr. Dancer has been for more than half his lifetime.

Of his connection with photography he has himself written, though in the modest and imperfect way one would expect such a man to write about himself. There is the stereoscopic camera with twin lenses, which as he explained, he was the first to make. He invented microscopic photographs, which so much delighted and astonished us 25 or 30 years ago. He also introduced photography to the magic lantern, being the first to show a photographic transparency on a screen; and the exhibitions which men of middle age will so well remember at the Mechanics' Institution, when Mr. E. Hutchins was the secretary, were largely due to Mr. Dancer, and were the first ever held. The lantern itself is also indebted to him, not only in its optical parts and its construction generally, but also particularly in the application of the oxy-hydrogen light, and for a dissolving gas tap, which saves half the gases and produces the best dissolving effect.

Then there should be mentioned, as of much greater importance than the above, the automatic "contact breaker," used probably by the million at this moment, in every induction coil in the world. Prior to Mr. Dancer's invention, contact used to be made and un-made by hand, in a vessel containing mercury. The first helical coil with the vibrating interrupter was constructed by Mr. Dancer, and was exhibited long after by him at one of the soirées of the British Association, when the meeting was held in Manchester.

When Mr. Dancer established himself as an optician in Manchester, his presence soon made itself felt amongst the few microscopists then living in the district. Good microscopes were then costly, and worthless ones very common. Mr. Dancer successively brought out several forms of instruments, as excellent in their mechanical and optical arrangements as they were moderate in price. Instruments fully equal to the requirements of original research were thus brought within the reach of many whose observing faculties were more conspicuous than their financial resources. It would be difficult to over estimate the stimulus which Mr. Dancer thus gave to Manchester microscopy; it cannot be doubted that the present energy of our local microscopists is the direct outcome of the impulse which their means of research then received.

Not only so, but the value of the new instruments was recognised outside our city, by such men as Mr. Quekett, Dr. William Carpenter, Dr. Gideon Mantell, and Mr. Bransby Cooper, all of whom were familiar with their excellent qualities. These facts suggest that Mr. Dancer's claims upon us are worthy of recognition by many now treading in paths which he made easy for them, though personally a stranger to them.

This is a considerable catalogue for one man to be concerned in; but it does not complete the list. Mr. Dancer mentions the porous jar in his letter, which he was the first to suggest in the Daniell's battery, and which it is difficult to over estimate the importance of. There are also his improvements in levels; the speed counter; an instrument for testing coloured fabrics for calico printers; improvements in air pumps; improvements in voltaic batteries, &c., &c.

It is sad to have to say, that notwithstanding Mr. Dancer's talents and achievements, he is now living in very straitened circumstances, is moreover afflicted with almost total blindness, and therefore unable to follow the optical business to which his life has been devoted. It is not an unusual thing for a man of great mechanical ingenuity and skill to be an indifferent man of the world, and so it has been with him; as a business man he has been a failure. He has made improvement after improvement, invention after invention, any one of which might in "pushing" hands have made a fortune; but more interested in science than in money-making, he has allowed the golden chances to become public property, and has thus remained poor himself, while the world has reaped the advantage of his labours.

Mr. Dancer is now in his seventy-fourth year, and we beg respectfully to suggest that in his hour of darkness the world should pay back to him something for that which it has freely received at his hands.

We propose that a subscription be commenced forthwith, with the object of purchasing an annuity, payable during the joint lives of himself and Mrs. Dancer.

We are willing to form the nucleus of a committee for carrying out this project, and invite all friends to Mr. Dancer to join us in obtaining subscriptions. Mr. T. R. Wilkinson, manager of the Manchester and Salford Bank, has consented to act as treasurer, and cheques can be paid to his order, or payments to the credit of the "Dancer Subscription," will be received at the Bank.

J. P. JOULE, LL.D., F.R.S., Sale, near Manchester.
Prof. W. C. WILLIAMSON, LL.D., F.R.S., Owens College.
Prof. BALFOUR STEWART, LL.D., F.R.S., Owens College.
JOHN DALE, F.C.S., Cornbrook, Manchester.
LEO H. GRINDON, Manchester.
S. PLATT, J.P., Oldham.
CHARLES BAILEY, Hon. Treasurer Manchester Literary and Philosophical Society.
JAMES BIRCHALL, Hon. Secretary Liverpool Literary and Philosophical Society.
ABEL HEYWOOD, Jun., Higher Broughton, Manchester (Hon. Sec. *pro tem.*)

NOTES.

Electric Lighting of Shops in Newcastle.—The large and commodious stores being erected by the Newcastle Co-operative Society, and which are nearly completed, in Newgate Street of that city, are to be lighted by four Gülcher arc electric lamps of "2,000" candle-power each, and 102 incandescent lamps of "20" candle-power each.

The Electric Lighting at Paddington.—Last Friday a number of representative colonial gentlemen visited the premises of the Great Western Railway, Paddington, at the invitation of the Telegraph Construction and Maintenance Company, for the purpose of viewing the electric lighting installation. The visitors included Sir George and Lady Bowen, Mr. Bosisto, Mr. Despeissis, Mr. Glen Engelhardt, Mr. George Hawkins, Mr. and Mrs. Malcolm Fraser, Sir Peter and Lady Lumsden, and Mr. Schute. The various features of the machinery and lighting apparatus were explained to the visitors by Mr. J. E. H. Gordon, whose inventions are principally adopted in the system of electric lighting in operation at Paddington.

Electric Light Experiments.—At the last meeting of the Bournemouth Improvement Commissioners a letter was read from Messrs. Laing, Wharton, and Down recommending the experimental introduction of the electric light into Bournemouth. After some discussion it was resolved on the recommendation of the committee, that facilities should be given for experimental electric lighting at the expense of the applicants, although the Board were not inclined to increase the present cost of lighting the town.

Temporary Lighting on Board Ship.—The electric light was temporarily installed on board the *Alexandra* upon the occasion of the banquet given on the 11th inst. by H.R.H. the Duke of Edinburgh to the flag officers and captains of the ships of various nationality at the time in Suda Bay which have been engaged in the blockade of the Greek ports.

Electric Lighting and Crime.—According to the *Diamond Fields Advertiser*, South Africa, the electric light played an important part in the criminal proceedings relating to the dynamite conspiracy. According to one of the witnesses, he was able to identify the accused because the latter got directly between him and an electric light, which was at a distance of some 360 yards. Mr. Preece has said that an increase in electric lighting would lead to a decrease of policemen. If it does not have that effect, it may at any rate cause policemen to be oftener visible when their services are required.

The Brush Cut-Out.—Tests with the Brush multiple series cut-out at the station of the Brush Electric Light Company, of Boston, are stated to have been very successful. An account says that the lamps had already shown a life of 800 hours and were still burning.

Electric Lighting for San Francisco.—The street lighting committee of San Francisco have asked for "proposals" for maintaining 28 electric light masts for two years from August 1st next. One mast is to be 40 feet high, and the rest 150 feet.

The International Cable Company. — Since the publication last week in the *Financial News* of portions of a prospectus of this company, stated to be in circulation on the Continent, two of the gentlemen whose names were given as directors have written denying any connection with the company.

The Proposed New Zealand-Australia Cable. — According to a contemporary three companies have signified their willingness to construct a proposed new cable from New Zealand to Australia for £180,000.

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The Manufacture of Bell Telephones.—The gross output of telephones of the American Bell Telephone Company for May was 4,555, an increase of 848 upon the output of the same month in the previous year. The gross output for the period from December 21st to March 20th last was 17,054, an increase as compared with the corresponding period of the previous year of 2,732.

Canadian Telegraph Lines.—*Bradstreet's* says:—"The proposed deal between the Canadian Pacific Railway Company and the Western Union Telegraph Company in regard to the telegraph lines of the Dominion has for the time being come to naught. The negotiations were brought about as a consequence of the establishment by the Canadian Pacific directors of a telegraph line along the whole of their system from Quebec to British Columbia, the existence of which, with branches now contemplated, in the absence of some agreement, is certain to severely interfere with the practical monopoly of the Canadian telegraph business now enjoyed by the Western Union.

A New Telegraph Office.—For some time past dissatisfaction has existed among the inhabitants of Cattedown on account of the absence of a telegraph office. Sir Edward Bates, M.P., was got to interest himself in the matter, with the result that a promise has been received from the Postmaster-General that a telegraph office shall be opened there, especially with a view to the convenience of the captains of merchant ships lying at anchor in the vicinity.

Colonial Telegraphs.—Mr. J. Sivewright is announced to read a paper on "Colonial Telegraphs," on July 9th, in connection with the Colonial and Indian Exhibition Conference.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to June 19th, 1886, amounted to £335,000; from April 1st to June 20th, 1885, they were £355,000.

The Libel on Mr. Watt.—At Westminster, on Saturday, Richard Fyfe, engineer, was charged, on remand, with libelling Mr. Hugh Watt, one of the members of Parliament for the City of Glasgow. Mr. J. G. Grain, who appeared on behalf of the prosecutor, stated that since the prisoner had been in custody, after his re-arrest, consequent on his absconding from his bail, he had written letters to Mr. Watt, begging his forgiveness, and offering the most ample apology. The learned counsel read the communications, which were dated from Holloway Prison. The defendant therein expressed his humble regret for that which he had penned, stating that there was not the slightest foundation for the allegations he had made. Mr. Partridge remarked that there was some aggravation of the offence, because the charges were reiterated by the accused when he was first in custody. Mr. Grain said that Mr. Watt was willing to withdraw from the prosecution under all the circumstances. Mr. Partridge discharged the defendant, remaking that he should most certainly estreat his recognisances for absconding from his bail if there was any application made with that view.

Our Columns.—This number of the REVIEW, being the last of Vol. 18, contains the index. As a consequence, we have necessarily been obliged to leave over all reference to the evidence in the incandescent lamp patent case, the "Strange History of a Dynamo," and other matters of interest.

Electric Light Fire Damp Indicator.—With reference to the apparatus which we describe on page 588, we would remark that the principle involved in the instrument is an old and well-known one, and it possesses the defect (which we believe must exist in the apparatus in question) that it does not enable a *gradual* accumulation of fire damp to be indicated.

Volk's Electric Railway.—The proposal of Mr. Volk to construct a passing place on his railway again engaged the attention of the Brighton Town Council at their last meeting, when the Works Committee reported that the resolution of the council excepting from approval their recommendation that Mr. Volk's application should not be granted had been under their consideration, and it was resolved that the permission should be granted, subject to the same conditions as those upon which the existing railway is permitted. A rather animated discussion was initiated, Councillor Carpenter objecting to any fresh concession being granted to Mr. Volk, and moving an amendment to the committee's report. It was suggested that certain members of the corporation used the electric railway gratuitously, and that, indeed, free passes had been sent to every member of the council. The necessary permission was ultimately granted to Mr. Volk by an overwhelming majority. Councillor Carpenter would not, however, allow the matter to stop there. He had a fresh grievance. He said that he had sent a letter to the committee enquiring by whose authority the beach adjoining the electric railway had been levelled on the east side of the Charlotte Street groyne; and the committee resolved that he should be informed that the work had been commenced without their authority, and had consequently been stopped. He contended that originally he was given a different version of the matter, and thought that private individuals should not be allowed to take hold of public property. An explanation having been given, the wearisome discussion ended.

Electric Locomotion in Philadelphia.—A daily paper states that an experimental electric motor car has recently been run in Ridge Avenue, between Thirty-Second and Thirty-Third Streets, Philadelphia, by the Union Electric Company, the speed attained being at the rate of nine miles an hour. The system employed is that of underground electrical transmission. A conduit 4½-inch wide by 9-inch deep, and having a central slot similar to those used in cable roads, extends along the centre of the track. This has been laid on concrete, and covered with Portland cement. At suitable intervals connections are made with the sewer in order to allow the rain water to escape, or the conduit to be cleansed out if that operation should become necessary. Copper conductors, quarter of an inch thick by one inch wide, run along each side of the slot. Grooved pieces of channel iron are attached to the bottom of the conductors. A so-called "traveller," supported by wheels, runs in the slot, and is provided with two springs, which slide along the channel irons on each side of the slot, and thus receive the electric current. The traveller is connected to the car by small chains. From its centre wires extend into the car, connecting the motor with the copper conductors in the conduit, by which the electric circuit may be closed. A regulator on the car controls the current and permits the car to be driven in either direction. The estimated cost per day of running the electric car is stated to be $1.84, as compared with $4.74 for horse traction, both amounts not including wages. The cost of ten miles of electric railway on this system, and 50 cars, is stated to be $175,000 (£35,000).

Primary Batteries.—Mr. Sidney F. Walker occupies a considerable portion of our space this week with strictures on the Upward and the Schanschieff batteries, and in praise of that of Maquay. Doubtless, Mr. Upward can reply to all the points raised in our correspondent's lengthy communication, and Mr. Schanschieff is also able to take care of himself.

The Gordon Method of Lighting.—We understand that there is a probability of the Gordon system of electric lighting being introduced into the United States as a rival to that of Edison. The American electrician should construct a machine giving reverse currents, it could then be offered to the public as an "alternative" system.

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An Unfortunate Company.—The building of the Royal Electric Company, Montreal, was burnt down last month. The total damage is stated to have amounted to $50,000, but was covered by insurance. This company has been unfortunate in regard to its premises. The building it formerly occupied was burnt down, and that which has just been destroyed was inundated during the recent flood.

Strong Plea for Overhead Wires.—The *Baltimore Herald* says it is no use talking about taking down the telephone poles till the anarchists have left the country. The lamp posts are not high enough; besides, they will only support one at a time.

Electrical Elevated Railroads.—The committee on street railways of the Massachusetts Legislature, it is stated, will report that the time has not yet come to say that electrical elevated roads are a success, and that they think the methods should be more fully developed before any charters are granted.

Collapse of the Electric Lighting Bill.—Many of our readers will probably be glad to learn that the Electric Lighting Act Amendment Bill which the House of Lords Select Committee evolved after a strangely elaborate and secret enquiry has, after all, come to nothing.

The Electric Lighting of Chelsea.—The Board of Trade has granted a provisional order, which will require the confirmation of Parliament, to the Chelsea Electricity Supply Company, Limited, with powers to supply, under certain conditions, an area comprising the whole of the parish of Chelsea, exclusive of the outlying district of Kensal Town. The order stipulates that within one year from the commencement of the powers the company shall set aside £100,000 as separate capital for the purpose of carrying out the powers granted in the order, failing which the board reserve to themselves the right to revoke the order upon such terms as they think fit. Provision is also made for regulating the charges leviable by the company, and for testing, by the local authority, the supply of electricity.

New Electric Fuzes.—The Electric Blasting Apparatus Company, of Cinderford, Gloucestershire, writes to us as follows:—"We notice reference in your issue of the 11th to a 'New Electric Fuze,' by MM. Scola and Ruggieri, extracted from the *Comptes Rendus*. We feel compelled in justice to ourselves to ask to be allowed to say we have been doing an extensive business (as enclosed testimonials will show) for some years past with a fuze made on this principle, more particularly in connection with coal mining and subaqueous work."

The Upward Primary Battery.—We were conversing the other day with a gentleman of the highest eminence in the electrical world, and he expressed himself to the effect that he considered this battery as being a great advance on anything which had been previously accomplished. We imagine that extensive use could be made of Mr. Upward's invention in America, where the price of gas averages about 9 shillings per 1000 cubic feet.

Bleaching by Electricity.—In the *Dyer and Calico Printer* for May 15th, Mr. W. Watson concludes a series of articles on bleaching by electricity, and he arrives at this conclusion:—"We may say that we do not think it possible any development will ever take place in the bleaching of vegetable fibre by electricity of sufficient importance to be worth the attention of practical men." What say Messrs. Paterson & Cooper to this sweeping assertion?

Colonial and Indian Exhibition.—At the conference on Wednesday, June 23rd, a paper was read by Mr. W. Lant Carpenter, on "The Position of Science in Colonial Education." The colonies to which Mr. Carpenter had directed his attention were:—Canada generally; in South Africa, the Cape of Good Hope and Natal; Western and South Australia, Victoria, New South Wales, Queensland, New Zealand, and Tasmania, the last of which, unfortunately, was not represented at the present exhibition. An account of the present condition of scientific education in each of these colonies was given. As a general conclusion, Mr. Carpenter thought that the claims of science to a place in state-aided primary education were more fully recognised than in the old country, and this, not merely because it was the only foundation upon which a system of technological education could be securely built, but for its value in drawing out the minds of the pupils. In the colleges and universities of the older colonies, the classical and academic influence was still very strong, while in the newer ones the claims of scientific education to be put on an equal footing with literary were recognised. The author concluded his paper by throwing out the suggestion that, if there were grave and practical difficulties in the way of an Imperial federation of the Australian colonies, the establishment of an Australian Association for the advancement of science, somewhat on the lines of the British and American Associations for similar purposes, might not be beyond the reach of practical scientists, and he was strongly of opinion that such a federation would tend to strengthen "the position of science in colonial education."

Electrical Measuring Instruments.—In the latest issue of *Centralblatt für Elektrotechnik* there appears an article on tramway traction, and special mention is made of a trial of the Julian system in Hamburg. This, as our readers may remember, was tried in competition with steam and compressed air engines during the Antwerp Exhibition, coming out of the contest ahead of its rivals on nearly every point. Our contemporary speaks of some measurements being made with instruments by Paterson and Cooper, Breguet, Ayrton and Perry and others, the readings given varying between 20 and 30 per cent. The Julian system might evidently be made very good or very bad according to taste with such a charming set of apparatus to select from.

Telegraphic Communication.—"J. E. K." writes to the *Times*:—"If I might generalise from a single district I should say that the state of our telegraphic communications calls for immediate and serious attention. A complaint which I made to the West District office in Vere Street has brought to my knowledge the fact that the number of blunders which draw forth similar complaints to that office alone amounts to 30 or 40 a day. Possibly some of these may be attributable to the senders—mine was not; but to set against this we must take into account those about which the offices hear nothing. Telegraphic communications are for the most part about matters of more than ordinary importance and such as need more than common expedition; but if addresses containing three figures, say 184, are wired with only one (8) what chance is there of the message reaching its destination within any time upon which the sender can reasonably calculate? This is one specimen of the variety of blunders to which we shall continue to be liable until greater care is exercised, and more efficient agents are employed." A little experience of our own a week or so ago still rankles in our mind, a grievous error in the transmission of a telegram from London to Somersetshire having caused a degree of inconvenience and anxiety which it is hard to calculate.

The New York Underground Wire Commission.—Renewed interest in the underground question is

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caused by the appointment of Mr. Roswell P. Flower to fill the vacancy on the New York Commission created by the death of Mr. Loew. The fact that the newly-appointed commissioner acknowledges his entire ignorance of the technical questions involved, states the New York *Electrician and Electrical Engineer*, will by no means hasten the work, unless he accepts for granted the conclusions already arrived at by the other members of the commission, but which they have not yet felt sufficient confidence in to publish as an official decision. Mr. Flower expresses the opinion that the law should be enforced, but his views upon this point may be slightly modified after he has carefully studied the provisions of the Act. If he will take the 118 plans which have been submitted, and retire to his accustomed summer resort, and carefully digest them, he will doubtless return next autumn fully convinced that his mind is not as clear upon the question of enforcing the law as it is at the present time.

Electricity and Fire.—Mr. Alfred Thompson who recently read a paper on "Electricity as a Safeguard against Fire," before the Balloon Society of Great Britain, thus sums up the advantages of the Automatic Electric Fire Extinguisher :—

1. Its instantaneous and certain action on the occurrence of a fire, either during the day or night. In this respect it is far ahead of all previous inventions.

The records of insurance companies show that while three-fourths of the fires in mills occur in the day time, more than three-fourths of the total loss has been caused by fire which started at night or on Sunday.

2. Its perfect automatic action and independence of human aid, which is of the highest importance, as frequently fumes of smoke are such as to endanger human life.

3. It confines a fire to the point where it originated.

4. The discharge of water is limited to the site of the fire, but can, if desired, be extended as a matter of precaution in an area immediately surrounding it by bringing into action other extinguishers in its immediate vicinity. This can at once be done with perfect ease and safety.

5. The apparatus admits of frequent testing to prove it is in working order. This can be done during working hours without interference to the occupants, or disturbance or damage to the furniture or fittings of the room. The testing does not necessitate any expense in the replacement of any part of the apparatus.

6. It is a perfectly reliable fire alarm.

7. It does what no other automatic fire alarm can do, viz., shows on a board plan the exact site of the fire indicated.

If, therefore, we may be guided by the advantages resulting from the application of electricity in all the above-mentioned cases, it is fair to infer that the application of electricity in the actuating of sprinklers will result in a still further saving.

NEW COMPANY REGISTERED.

Electro Metal Extracting, Refining and Plating Company, Limited.—Capital, £5C,000 in £1 shares. Objects :—To extract and refine metals by the electro process and to galvanise and plate iron and other metal goods by electrolysis or otherwise. Signatories (with one share each) :—T. F. Veasey, 76, Finsbury Pavement ; J. J. Done, 10, Finsbury Square ; A. Odell, 13, Kempsford Road, S.E. ; B. Wyand, Edgware ; A. W. Pym, 43, Ashburton Grove, Holloway ; T. Fenwick, 172, Fleet Street ; J. Marsh, 4, Wellclose Square. The first directors are—Messrs. F. B. Welch, C. S. Brand, T. Veasey, and T. Fenwick ; qualification 50 shares ; remuneration £50 per annum, with an additional £50 fee for the chairman. Registered 22nd inst. by Thos. Veasey & Co., 76, Finsbury Pavement, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

River Plate Telephone and Electric Light Company, Limited.—The annual return of this company made up to the 14th inst. was filed on the 21st inst. The nominal capital is £100,000 in £5 shares. 12,602 shares and 280 share warrants have been taken up, and the full amount has been called thereupon. The calls paid amount to £32,360, and £32,050 is considered as paid upon 6,410 shares.

Telpherage Company, Limited.—The annual return of this company made up to March 31st was filed on the 16th inst. The nominal capital is £50,000 divided into 2,500 A and 2,500 B shares of £10 each. £10 per share has been called upon the B shares, the calls paid amounting to £15,366 5s. and unpaid to £793 15s.

Swan United Electric Light Company, Limited.—The registered office of this company is now situate at 14, Albert Mansions, Victoria Street, S.W.

Alfred Slatter, Limited. — An agreement dated April 30th and registered 3rd inst. provides for the purchase of the business of electrical engineer, carried on by Mr. Alfred Slatter at Leadenhall Chambers, St. Mary Axe, and Sekforde Street, Clerkenwell, the consideration being £2,000 in fully paid shares. The vendor is appointed sole director and manager for so long as he may be willing to act at a salary of £250 per annum.

Bright Platinum Plating Company, Limited.—By an agreement dated 22nd ult. and filed on the 17th inst., the company will purchase from W. A. Thoms and J. S. Beeman the provisionally protected invention for improvements in the deposition of platinum by electricity (No. 4,553 dated April 1st, 1886). The purchase consideration is £300 in cash to be invested in shares of the company, and 600 fully paid shares.

CITY NOTES.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.—This company announces that the coupon due July 1st on its five per cent. Australian Government subsidy debentures will be paid on and after that date at Messrs. Barclay, Bevan & Co.'s Bank. Coupons must be left three clear days for examination. The same company also announces an interim dividend for the quarter ended March 31st last of 2s. 6d. per share, free of income tax, payable on July 15th.

South African Brush Electric Light and Power Company, Limited.—The liquidator announces that a third and final return to the shareholders of 1s. 9½d. per share is now payable at his office, 5, Copthall Buildings, E.C.

British Electric Light Company, Limited. — An order has been made for the winding up of this company.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estima receipts for the half-month ended the 15th June are £2,460, as compar with £3,050 in the corresponding period of 1885.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 18th were £2,110, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

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NEW PATENTS—1886.

7736. "Induction telephone repeaters." S. F. SHELBOURNE. Dated June 9.

7737. "Electric arc lamps." H. MOEHRING. Dated June 9. (*Complete.*)

7748. "Lightning guard for poles and supports carrying electrical conductors." A. R. BENNETT. Dated June 9.

7749. "Telephonic switching apparatus." A. R. BENNETT, C. G. WRIGHT. Dated June 9.

7795. "Electric lamps." H. N. BICKERTON. Dated June 10.

7806. "Producing intermittent electric light." P. JENSEN. (Communicated by K. Pollak and G. Wehr.) Dated June 10.

7848. "Secondary batteries." C. SMITH. Dated June 11.

7851. "Transmitters or receivers for mechanical telephones; making same." J. FRASER. Dated June 11.

7860. "Dynamo-electric machines." S. P. THOMPSON. Dated June 11. (*Complete.*)

7913. "Coupling engines and dynamos together." R. C. PARSONS. Dated June 12.

7916. "Mechanical telephones." F. J. MUDFORD. Dated June 12.

7919. "Incandescent electric lamps." R. KENNEDY, R. DICK. Dated June 12.

7953. "Regulating currents generated by dynamo-electric generators." W. GEIPEL. Dated June 15.

7966. "Secondary batteries acting as accumulators of electricity." E. COMMELIN, G. BAILHACHE, C. DESMAZURES, A. L. DE VOILOY, L. DE BOUSIGNAC. Dated June 15.

7983. "Constructing and automatically regulating primary batteries." A. SERRAILIER. Dated June 15.

7989. "Electrical membrane telephones." STANHOPE COMPANY, G. L. ANDERS. Dated June 15.

7990. "Diaphragms or tympans for electrical telephones, known as membrane telephones." STANHOPE COMPANY, G. L. ANDERS. Dated June 15.

7997. "Accumulators of electricity." J. E. CHAUME, P. PERRIER. Dated June 15.

8003. "Dynamo-electric generators." L. B. ATKINSON, W. T. GOOLDEN, A. P. TROTTER.

8007. "Propelling carriages by combined use of compressed air and electricity." W. HUTCHINSON. Dated June 16.

8019. "Dynamo-electric generating apparatus for electric lighting, &c., on board ships." G. A. SMITH. Dated June 16.

8029. "Telephonic instruments." H. WITHY. Dated June 16.

8040. "Regulating alternating electric currents." C. ZIPERNOWSKI, M. DERI, O. T. BLATHY. Dated June 16.

8084. "Voltaic batteries." A. M. CLARK. (Communicated by C. R. Goodwin.) Dated June 17.

8085. "Electrical thief-proof lock." R. D. BOWMAN. Dated June 17.

8137. "Incandescent electric lamps." A. SWAN. Dated June 19.

8151. "Making carbons for electrical purposes." J. G. TONGUE. (Communicated by J. Kirby.) Dated June 19. (*Complete.*)

8156. "Helical carbons for electric lamps." W. R. JOHNSTON. Dated June 19.

8181. "Electric clocks." J. G. LORRAIN. Dated June 21.

8226. "Secondary batteries or accumulators." A. M. CLARK. (Communicated by A. E. Peyrusson.) Dated June 22.

8230. "Apparatus or instruments for finding the variations and deviations of the compass." R. E. HARRIS. Dated June 22. (*Complete.*)

8246. "Insulators for supporting electrical conductors." A. R. BENNETT. Dated June 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

2081. "Improvements in and connected with telephonic apparatus." L. DE COMBETTES. Dated February 12. 8d. Relates to an electric apparatus serving to form telephone relays or stations, and to print telephonic messages upon a strip or band which is gradually unwound for that purpose. The improved apparatus is based upon the principle that a body increases in volume when magnetised, and that such increase is in a direct ratio with the extent to which it is magnetised.

2959. "Improvements in electrical brushes." W. T. WHITEMAN. (Communicated from abroad by W. H. Miles, junior, and J. C. Aiken, both of New York.) Dated March 2. 8d. Relates to brushes, particularly the hair or flesh brushes commonly used for toilet purposes, and consists in combining with the brush an electrical apparatus or generator, adapted to be operated automatically in using the brush to give a succession of discharges.

3133. "Improvements in and relating to electrical conductors." W. R. LAKE. (Communicated from abroad by H. A. Clark, of America.) Dated March 5. 8d. Consists partly of an electric conductor, composed of a bare or core wire, of steel or iron, or of other suitable material that is a good conductor of electricity, and preferably one that combines strength and durability, having one or more grooves along its length either longitudinally or spirally, one or more insulated electric wires lying or being disposed in each of said grooves; a covering or coating of any suitable insulating material, such as India-rubber or gutta-percha, or the like; and an outside covering such as silk, cotton, or other suitable fibrous material, either braided, wound, or wrapped spirally or longitudinally thereon, or applied in any other suitable manner; or such as lead applied in any suitable manner. The invention also consists partly of a longitudinally or spirally grooved bare or core wire, having an insulated electric wire or wires in each groove, and the whole covered with a fibrous material. It also partly consists of a longitudinally grooved bare or core wire, having an insulated electric wire or wires in each groove, and the whole covered with a fibrous material, and an exterior covering of lead. It also partly consists of a longitudinally or spirally grooved bare or core wire, having an insulated electric wire or wires in each groove, and the whole covered with any suitable insulating material.

3135. "Improvements in electric cables." W. R. LAKE. (Communicated from abroad by H. A. Clark, of America.) Dated March 5. 6d. Relates to a cable for telephonic, telegraphic, and other electrical purposes generally; the object being to provide a cable in which leakage shall be prevented, and inductive effects of any wire upon the others obviated as far as possible.

3587. "Improvements in vibrating electric motors." A. L. PARCELLE. Dated August 11. 8d. Consists of a spring tongue, reed or bar, or of a pivotted non-resilient bar, provided with supplementary opposing springs, and may be of any suitable or desirable material. The armature upon which the motor magnets act is located upon the end of the vibrator, and lies in a plane transverse to its longitudinal axis. The motor or vibrator magnets are arranged opposite the armature with the faces of their poles in a plane parallel or substantially parallel therewith, so that the armature vibrates across the faces of the magnets. The local circuits through the motor magnets are opened and closed by the vibrator in its movement, as is well understood.

3670. "An electric incubator and foster-mother." H. NEUMANN. Dated March 16. 8d. This apparatus is designed to effect the hatching of eggs and the protection of young birds by means of warmth derived from an electric current. It consists of three main parts, viz.: (1) the nest, (2) a special cover, and (3) the battery, thermo-pile, or dynamo with its supply and return wires, thermometer, and magnetic coil, forming when fixed an automatic cut-off or regulator for adjusting the temperature of the nest.

3726. "Improvements in galvanic batteries." H. H. LAKE. (Communicated from abroad by J. Serson, of America.) Dated March 16. 8d. Consists in certain improvements in the construction of the outer jar, inner cell, and electrodes, whereby the inventor is enabled to charge the batteries in a way to obtain the most effective results.

4058. "Improvements in telegraphic recording instruments." A. M. CLARK. (Communicated from abroad by the New Haven Clock Company, of America.) Dated March 23. 8d. Consists, first, in the employment of a cutting roller in the place of a cutting pin for marking the paper where the same is in contact with another roller; second, in providing the apparatus with a slide to which the electro-magnets, the armature, the binding post, and the electrical conductors are secured, and which slide can readily be removed from the remainder of the instrument for inspection and repair; and, finally, the invention consists in providing said sliding portion with a non-conducting plate in which the binding posts and the ends of the conductors are secured.

4072. "Improvements in telegraphic recording instruments." A. M. CLARK. (Communicated from abroad by the New Haven Clock Company, of America.) Dated March 23. 8d. Relates to sundry improvements in telegraphic recording instruments which are instruments for printing or marking messages upon strips of paper, the marking instruments indenting a strip which is fed through the machine by clockwork. The first part of the present invention consists in making the indenting roller which is carried by the armature lever adjustable on said lever for the purpose of regulating the depths of the indentations produced in accordance with the size of the indenting roller, thickness of paper, or thickness of feed-roller. Secondly, the invention consists in making the feed lever, that is to say, the lever which locks and releases the clock work, in two parts of which one is adjusted to regulate the stroke of said lever. Thirdly, the invention consists in constructing a paper guide of two sliding cheek pieces fitted upon a right and left screw. Fourthly, the invention consists in a new manner of hanging the upper feed roller so that it can be adjusted by one screw; and—finally, it consists in rigidly connecting the spring of the reel shaft to the washer.

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CORRESPONDENCE.

Arc and Glow Lamps.

A correspondent has been making enquiries respecting a book on incandescent lamp manufacture.

Although at present no such book has been published, the want will shortly be supplied by the appearance of the new volume of our "Specialists' Series," to be ready in about a fortnight.

The book is written by Julius Maier, Ph. D., and entitled "Arc and Glow Lamps," a practical hand-book on electric lighting.

Immediately on the appearance of the volume, a copy will be sent to your paper for notice.

Whittaker & Co.

London, *June 23rd*, 1886.

Primary Batteries.

It is evident from the frequent correspondence upon the above subject in your columns that they are once more coming to the fore; and there is no doubt that there is a very large field for a good primary battery. There are numbers of private houses in which the incandescent lamp would be an inestimable boon, and whose owners would not be critical as to whether the cost of working exceeded that of gas or not, so long as it was not excessive, and the service was good; that is to say, that they could have a good light when and where they wanted it; but where an engine and dynamo would be out of the question. The convenience and comfort of the incandescent lamp hardly require pointing out to electrical engineers; yet it may be well to mention that this extra convenience and the avoidance of smoke, heat, destruction of furniture, makes it worth more money than gas or oil as an illuminating agent.

At the same time, I think we should be most unwise to deceive ourselves with the hope that the average English domestic will ever—or at least for some years to come—accomplish the feat of attending to a primary battery, so far as we know them at present arranged for lighting, even though it be of the simplest form.

And for this reason, though we should gladly welcome a new departure such as Mr. Upward has made, in the hope that it may lead us by and by to something good; we cannot help feeling that, with our present knowledge, and with the present habits of domestic servants, and even the knowledge and habits of the present race of men who may be set to look after these batteries by the makers or contractors, he has made a step in the wrong direction. His apparatus is far too complicated; you have first your chlorine generator, then your primary battery, then your secondary battery, and connecting or attached to these various chemical and electrical appliances, designed to keep everything right, but each one being itself a possible source of failure.

I think it may be safely assumed that no domestic servant and few battery men are to be trusted to manage a chlorine generator.

Experience has shown that in order that any electrical apparatus shall be successful, when used by the general public, one of two conditions is necessary. Either the whole apparatus itself must be so simple as to require practically no attention, or a sufficient number must be used, or those used be of sufficient importance to warrant the employment of a skilled man specially to look after them. The number of electric bells in private houses, and of electric signals anywhere except on railways, was very small indeed previous to the advent of the Leclanché battery. And it will be the same with lighting batteries. We can hardly hope for them to become as simple in working as the Leclanché in its sphere for many years to come; and we shall, therefore, have to fall back upon the attendant battery man. This official may in time learn to manage the chlorine generator, and to keep all the multitude of apparatus that are attached in order. But for my own part I should prefer setting him before an honest bichromate battery, and I think the results would be more satisfactory.

And now as to the chlorine gas battery itself, and the advantages claimed for it. I note that while in *Engineering* it is stated that the zinc stands in a solution of chloride of zinc, in your correspondent's description plain water only is mentioned. Probably what takes place is, the inner cell is filled with plain water, but the battery does not begin to furnish much current until the water has penetrated to the carbon on the one hand, so as to form a liquid passage for the current, and, on the other, until the solution surrounding the zinc is more or less impregnated with chloride of zinc.

The action I take to be as follows: zinc combines with the oxygen of the water, and possibly with some of the chlorine, while hydrogen is set free in the carbon cell, combining there with the chlorine gas to form H Cl.

If this is so it is sheer nonsense to talk of no depolariser being employed; and, as every electrician knows, the depolariser is not a source of power, but a remover of a source of weakness.

Again, it is stated that the very commonest zinc may be used, that it requires no amalgamation, and no attention, as there is absolutely no local action. I should like to ask here what happens if there happens to be a small piece of iron cast in the zinc; or if, as almost invariably happens with cast zinc, different portions of the rod are in different conditions, will you leave any the less formations of those minute batteries which we know as local action, though no acids are employed? They may not be so active because the resistance of the connecting liquid is comparatively high; but this is against the battery itself. I think, too, that in practice the beautiful freedom from attendance which the inventor expects would hardly be realised, and it is worth noting that in order to get rid of the necessity of putting acids in the battery—an operation which any battery man can perform, and with which he is perfectly familiar—the chlorine generator is added, necessitating itself the addition of acid and the washing out and manipulating of apparatus that he probably never saw before, and that he has an uneasy feeling that it will blow up if he is not careful. The results given by M. Hospitalier of the tests of Mr. Schanschieff's battery are certainly very good, but they have been exceeded by a bichromate battery invented by Mr. Maquay, which I had the pleasure of testing some months back in London.

Mr. Schanschieff's battery besides has apparently two grave faults. Its E.M.F. is low, and the cost of solution is enormous. Even after allowing for the returned liquid at Mr. Schanschieff's own figures, and taking his own method of calculation, the cost for solution is very much in excess of that of Maquay's battery, as the figures given below will show.

I think, too, that Mr. Schanschieff has omitted the cost of collection of his spent liquids, which might be a serious item. The same causes which would prevent the British "slavey" from attending properly to a battery, would also militate rather seriously against the collection of spent liquids; and it is doubtful if even the battery man could be trusted to do this, in every case. It would be so much less trouble to throw it down the sink.

I think it will be wiser in our calculations not to depend upon the recovery of spent liquids for the present. Refresh them as much as possible, and when all has been done in that direction throw them away, and charge afresh.

The following figures, which are taken from a report made by me on the Maquay battery in December last, will probably be interesting. As I told the gentlemen who employed me, and I think most of your readers will agree with me, the results obtained far exceeded

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in many points anything that had previously been done, or that was thought possible, with primary batteries.

The battery tested consisted of six small cells contained in a cubical box measuring 3½ inches in the side, and weighing complete, when charged, 7 lbs.

It was connected in circuit with an incandescent lamp, and a very sensitive ammeter, reading to ·025 ampère.

It furnished a current of 1 ampère at 11½ volts. The readings were as follows :—

	Ampère.
At the start	1·0
2 hours after	1·0
2½ „ „	1·0
3 „ „	0·995, just under the 1 amp.
3½ „ „	0·975
4 „ „	0·960
4½ „ „	0·950
5 „ „	0·900
5½ „ „	0·85
6 „ „	0·825
following very slowly till	
7 hours after	0·525

I had no voltmeter by me sufficiently sensitive to follow the fall of E.M.F., but it will be seen from the above that it must have been small, as the resistance of the incandescent lamp would rise as the current fell.

I, however, tested another battery containing 18 cells similar to those in the small battery. These were also connected to an incandescent lamp, and the E.M.F. tested from time to time. In four hours it only fell from 32·5 volts to 32·25 volts.

Since then I have had the opportunity of testing the working cost, in the workshop belonging to my firm, and I make it for solution alone, which is, I think, all that Mr. Sehanschieff has reckoned, and summing up the number of watt-hours furnished in the same manner that he has done, only 0·02d. per watt-hour as against 0·323d. per watt-hour with Mr. Schanschieff's battery.

Mr. Maquay has also worked out in connection with his battery, a system by which the zinc becomes thoroughly amalgamated all through, and will therefore wear as long as it will hold together, without reamalgamating.

Sydney F. Walker.

Cardiff, *June 22nd*, 1886.

Telephone Transmitters.

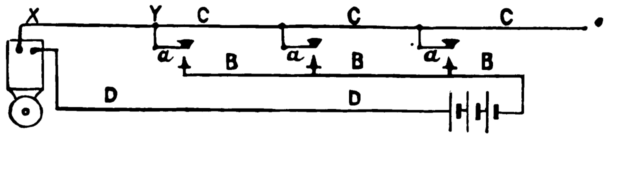
Would any of your correspondents kindly oblige by saying what a telephone transmitter should *not* be in order to avoid infringing the patent rights of the United Telephone Company ? I know carbon is not allowed ; but what are their other claims ?

W. Holder.

Newport, Mon., *June 22nd*, 1886.

Inter-Communications in Trains.

In your issue of May 21st, there was an article on this subject by Mr. Paul ; don't you think it would be almost as simple to have an arrangement such as shown in the accompanying diagram ? The



current is broken between the wires, B and C, and is established by pressing one of the pushes, *a*. With this arrangement the ordinary bell can be used ; instead of the wire, D, the rails or couplings, might be used.

I don't think it would be necessary to have a break-away signal in trains where the vacuum brake is used.

J. D. Leach.

31, Clifton Road, Aston, Birmingham.

[It is not at all obvious why our correspondent should suggest the use of *three* wires (or two wires and the rails), as it must be clear that the ordinary arrangement of placing the battery between the points, X and Y, and connecting the contact points of the keys either to a return wire or to the rails would answer just as well. Of course it would not be necessary to have a break-away signal in trains fitted with vacuum brakes, but the signalling arrangement of Mr. Paul is obviously meant for cases where such brakes are not fitted to the trains ; in such cases the suggestion of our correspondent would be useless.—Eds. Elec. Rev.]

A New Type of Dynamo.

In your last issue, when describing and illustrating the new Goolden and Trotter dynamo, you say: "A very similar pattern has recently been produced by Mr. Kapp." Your expression "*recently*" is, however, somewhat misleading, because with the rapid progress going on all around us one is hardly justified in describing a thing as recent which is more than a few weeks old. Now by referring to my books I find that the date of design and working drawings for the first single horseshoe machine falls into the period from July 24th to July 27th of last year, and that this machine was tested on August 28th of last year.

Moreover, the type of field which you call a recent production was described and illustrated last November in a paper I read at the Institution of Civil Engineers, and at that time several large dynamos of this pattern had already been made by Messrs. W. H. Allen & Co. to the order of the Admiralty.

Gisbert Kapp.

Wimbledon, *June 21st*, 1886.

Trembling Bells.

We observe in a recent issue of your journal an abstract of patent specification No. 7,373, 1885, relating to improvements in electric vibrating bells. The inventor, Mr. W. R. Wynne, claims the provision of a contact lever, separate from the armature, and provided with projections which engage with a projection on the armature. The whole is designed that circuit may not be broken until the armature has nearly completed its movement towards the magnet ; and that it may be established with similar delay. We shall be obliged if you will permit us to state, through your columns, that the principle of this invention was known to us at least two years ago ; and that in 1884 Mr. Wynne's application of it was embodied in the construction of electric bells, and an electric pen still in our possession.

We may add, that in the case of most bells, the improvement is of little value, owing to the like resulting effects of self induction.

T. S. & W. Taylor.

Leicester, *June 21st*, 1886.

Dynamo Engines.

In an editorial appearing in your issue of June 11th, bearing the above title some comparisons were made between the economy of the Westinghouse and other engines that, to say the least, were decidedly unfair.

How, or by what means, the data given were obtained, it is impossible for us even to guess, as no trials were made by us that gave such results, and no statements were published containing them. It is, of course, possible that the managers of the Electrical Review have disinterestedly carried on a series of trials that would benefit only the makers and buyers of high-speed engines, notably some of the former, but if this is the case why not mention it with full particulars ? Failing

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this we can only assume that the figures given of the Westinghouse engine's performance were mere guess-work.

We would ask, does a comparison of a simple engine of one type with a compound engine of another type, to the disadvantage of the former, appear to you as being in any way fair? Do you believe that a comparison of fuel burned comes within the bounds of common sense, when both are estimated from an alleged water consumption, and in one case the coal is supposed to evaporate 6½ lbs., and in the other 9 lbs. of water per pound of coal. The question of consumption of steam (not coal, that involving the economy of the boiler) in high-speed engines is an important one to the great mass of engine buyers and owners, as the tendency of the age is in the direction of faster speeded motors than are at present in general use, and it cannot be settled in a satisfactory manner by special trials, under special conditions, by special men who have special interests at stake.

There is, in fact, but one way to settle this matter for the present time, for in all cases the progress of the age makes any decision but temporary in its character, and that is in the appointment of a committee of disinterested experts by one of the leading scientific societies to investigate the subject and publicly report the results, as suggested by our Mr. Alley in the discussion of Mr. Imray's interesting paper on high-speed motors, read before the Institution of Civil Engineers at their November meeting, in 1885, in which he says:—"In connection with Mr. Imray's paper on high-speed motors, it would be most interesting to find out the exact consumption of steam per brake H.P. by practical tests conducted by a committee of experts in no way connected with, or interested in, the manufacture of high-speed motors. To carry out an investigation of this nature Messrs. Alley and Maclellan would be glad to supply a Westinghouse engine, and, if necessary, pay a portion of the cost of such experiments. He had no doubt that other makers of good high-speed motors would, for the sake of science, also be glad to join in the experiments to show what could be done by high-speed motors. If such data as the proposed committee would gather from these experiments were published it would determine the vexed question of the consumption of steam in high-speed motors of various types, in proportion to the actual available power given out by the crank shaft. He had no faith in power calculated from indicator diagrams in high-speed motors; these diagrams were only useful to show the points of cut-off and the expansion of the steam. A test by brake that would give the useful work was wanted, independent of statements made by inventors and manufacturers which might be considered more favourable than they deserved to be. With reliable data of this nature engineers would have more confidence in using high-speed single-acting motors."

Doubtless when that is done, the experts in charge will not compare the economy of one engine working with 95 lbs. pressure of steam with another working with 115 lbs. pressure per square inch.

In regard to other considerations of high-speed motors—and, by the way, what is high speed? How is it defined, and just at what point does an added revolution to an engine's turns per minute change its class from low or medium to high speed? You state in the article that you have a rooted antipathy to anything over 600 revolutions per minute, but for what type or size you do not mention. If you should attempt to run a 300-H.P. engine of any kind or class at this speed with the steam pressure at present in ordinary use you should find that it was an extremely high speed, and after wrecking the first engine your antipathy would root itself to a much lower maximum speed for that engine at least.

On the other hand a properly designed 3-H.P. single-acting engine would run successfully at double 600 revolutions, because it would not involve strains beyond the bounds of prudence or safety.

There are engines in use at the present time running 30 revolutions per minute, where an increase of a few turns per minute, would be ruinous to their good working. Therefore for these engines 30 revolutions should be called a high speed, for it closely approaches the limits at which they will work in a satisfactory manner, while other engines of a different design and the same or larger sizes are working smoothly and satisfactorily at double this speed, and that is not considered, nor is it, a high speed for these latter engines under the conditions they run.

Therefore, is it not plain that what is high speed for one engine, under certain conditions, may be extremely low for another, or even the same engine under different conditions. Although you do not state in the article referred to, it is implied, that the only use for high-speed motors is for direct connection to the machine sto be driven. And we may remark why not find objections to these machines for their high speeds, as well as the motors that drive them. Both to work well must be designed and built in accordance with the inflexible natural laws, therefore the objections would be as well founded in one case as the other.

But to return to direct connection, why should high-speed motors be only fit for that. If the machine is to be driven at a considerable speed by belts or ropes, is it not an advantage to have a motor to drive it running at nearly the same speed and belted to it direct, dispensing with the costly countershafting and its accessories and the inevitable bills for belting, oils and repairs that this slow-speed method entails, leaving out of the question the excessive space taken up in the latter case. A higher speeded motor will be cheaper in first cost, in cost of foundations and in erection expenses, and the saving from these sources on a 50-H.P. engine is too important an item to neglect.

In regard to repairs, the writer knows of several hundred, so-called, high-speed single-acting engines in America whose average yearly cost of repairs and of losses sustained through stoppage of work on that account, is much below what is considered good records with low-speed engines.

As to the question of wear, you assume, for instance, that because one crank shaft turns twice as fast per minute as another, it will wear away, or the bearing in which it revolves will be worn away in one half the time in the former than in the latter case, regardless of all other conditions.

Investigate this a little. Is not wear in proportion to pressure as well as speed? Does not lubrication have considerable influence on the amount and character of wear? and is it not a fact that in the best class of high-speed engines, notably the Westinghouse, the thorough lubrication of the working parts has been more completely arranged for and ensured than in any other class.

Take the case of two 100-H.P. engines, one running at 100 revolutions per minute, which will be classed as slow, and the other running at 300 revolutions per minute, which would be classed by many, though they might be unable to explain why, as a high-speed engine. As they are both to do the same work it does not appear unfair to say that their shaft bearings should have the same surface, and if made so probably we should be told that as one engine ran at one-third the speed of the other, its bearings would last three times as long. Look at it another way: one engine runs three times as fast as the other, therefore, to do the same work, its cylinder capacity need only be one-third as great and the pressure on its bearings one-third as much per square inch as its slow-speed competitors. Pressure × speed equals the same in each case, and the bearings should wear the same time; this is without considering the weights that are also sustained by these bearings. Taking the increased weight of fly-wheels, shaft, and connections into account, the pressure per square inch on the slow-speed engine bearings will be much greater than in the case with the fast-speed engine; a little figuring will prove this; for instance, the efficiency of a fly-wheel is in proportion to revolutions × diameter, and supposing the fly-wheel of the slow-speed engine to be three times the diameter of the other, it would require, in order to be as efficient, to have three times the rim weight,

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and would probably weigh four times as much as the fly-wheel of its fast-speed competitor, putting four times the pressure on the bearings from this source.

Therefore, in order to wear the same length of time, the bearings of the slow-speed engine would have to be made considerably larger than those of the fast-speed engine we have compared it with.

Alley and Maclellan,
Per H. G. BROWN.

[In the above communication our correspondents accuse us of unfairness because we based our remarks on tests of the Westinghouse engine, published in the *American Machinist* 18 months ago. In our leader on the subject we gave the steam consumption as well as that of the fuel, and since the former does not depend on the economy of the boilers our correspondents' indignant remarks on their evaporative power are entirely lost upon us. We should be glad to give publicity to any later tests of the Westinghouse engine, and under the circumstances we think our correspondents would have done wisely in furnishing us with more recent figures. For some reason or other unknown to us they refrain from doing so, but we are favoured instead with a collection of platitudes which must be familiar to every engineer. Doubtless the tests we instanced were published for the express purpose of showing what the engine could do, and we do not see that we were guilty of any unfairness in making them known to an extended circle of readers. Once for all, let us remark that we want figures, not generalities. Give us the figures and we can do the generalising for ourselves.

It is not for experts to dictate to the makers the pressure at which their engines should be worked, nor the speed at which they should run. Presumably makers know the working conditions best suited for their engines, and it is the duty of the expert who reports simply to test them under those conditions.

Our correspondents' remarks regarding the speed of dynamos and engines are absurd, for no comparison is possible where two machines differ so essentially in character. A dynamo of given power has a limiting speed far higher than that of any engine of the same power yet designed, and makers have reduced the speeds of their dynamos simply because they could not get engines to drive them direct at the speeds of which they were capable.

As regards the working of the Westinghouse engine we beg to quote from a price list published by Messrs. Alley and Maclellan, as follows:—"It is not claimed that unusual speed is without some objection; but we are confident that in this engine the loss due to it is reduced to such a point as to make its use highly advantageous in many circumstances. The fact that belts and shafting are dispensed with will more than compensate for loss in the engine due to high speed." From this it will be seen that our correspondents themselves admit a loss due to high speed, and from their list we learn further that 600 revolutions is the maximum speed for the smallest size of ordinary Westinghouse engine, the "special" type which runs faster being the type to which they apply the above quoted remarks. Further criticism is superfluous.—EDS. ELEC. REV.]

The Turnbull Telephone.

I was greatly surprised, and not a little amused, on reading in a New York newspaper the following:—

TURNBULL TELEPHONE IN ENGLAND.

"Mr. Townsend Percy recently spoke on long-distance telephony in America before the Royal Institute of Telegraph Engineers in London, being introduced by Mr. W. H. Preece, chief electrician of the English Government. The following week he was entertained at Stafford House by Lord Ronald Gower, brother of the Duke of Sutherland.

"Mr. Percy is introducing the Turnbull International Telephone in England."

A person by the name of W. C. Turnbull obtained a patent in the United States, February 23rd, 1886, No. 336,876, for a telephone transmitter. When it was on trial between this city and New York, over the Postal Telegraph Company's wire—made of steel covered with copper, 4 ohms resistance per mile, only one wire on each pole, it operated well—with a Morse [? Bell] receiver, as Turnbull had no patent for a receiver. I examined the instrument at that time, and published in the New York *Electrical Review* the following notice:—

ABOUT THE "TURNBULL" TELEPHONE.

Editors *Electrical Review*,—Your *Review* of 27th inst. contains some remarks about "the distinctive features of the *Turnbull* long-distance telephone," recently tested between this city and New York over the Postal Telegraph Company's lines, and which is being introduced to the investing public by a Pole, who represents himself to be a *Count*, and who served a short time as a private in the U.S. army during the late war.

Your notice of this instrument is calculated to inspire confidence in investors, and therefore I hope you will publish this my statement that the Turnbull transmitter—Patent No. 336,876, dated February 23, 1886—is clearly an infringement of the patent No. 250,308, June 8, 1881, the property of the Molecular Telephone Company, in which company I own a large number of shares. The Turnbull patent may be a valid patent, for the modifications it has of the patent 250,308, but the use of "carbon plates or bars suspended in an inclined position, and resting on carbon," constitutes the infringement. It is not surprising that the Turnbull transmitter operated well between Washington and New York—251 miles—for it is well known that the transmitter of the Molecular Telephone Company operated well between New York and Chicago—1,050 miles—in April, 1883.

W. C. BARNEY.

917, Sixteenth Street, Washington,
March 19th, 1886.

Upon examination of English patents I find that the so-called "Turnbull telephone" is identical with an instrument described in a patent—No. 2,265, May 24th—published in your REVIEW, January 28th, 1882, page 62.

Attempts are being made here by this *Count* to organise a company to work this telephone—one of which is to-day published as being at Alexandria, a small worn-out old town some seven miles from this city.

These incorporators must have great faith that there are many fools yet willing to part with their moneys, especially in face of the recent decisions in favour of the Bell patents.

There are many rumours about this Count, who is the prime promoter of this telephone. That Mr. Preece should have taken up such an instrument, so clearly an infringement of Edison, of Bell, and of Gent and Ellery patents, surprised me.

W. C. Barney.

Washington, *June 11th*, 1886.

Electricity v. Heat.

I regret to note, in your issue of May 7th, that you warn Mr. James Johnstone "not to do it again"—so to speak.

I am sorry. Flashes of genius such as he seems to be subject to are really refreshing, when one is constantly delving in the dry dust of the science.

An electrical friend suggests that Mr. Johnstone is correct in his theory of a triumvirate of molecules, heat, and electricity. To use his own words:

"Johnstone makes it perfectly plain, that when a fellow picks up a wire that has a heavy current, and receives a shock, it isn't electricity that hits him, its the heat that has been attracted from the surrounding atmosphere by the current, and he isn't shocked but burned."

Seriously, Mr. Johnstone does himself an injustice. He could make millions by using his heat absorbing wires for cooling beer vaults, instead of the expensive ammonia apparatus now in use. This is a scheme for suggesting which I ask only that Mr. Johnstone shall write more, and the REVIEW publish it.

C. H. Haskins.

Wisconsin Telephone Company,
Milwaukee, *June 4th*, 1886.

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